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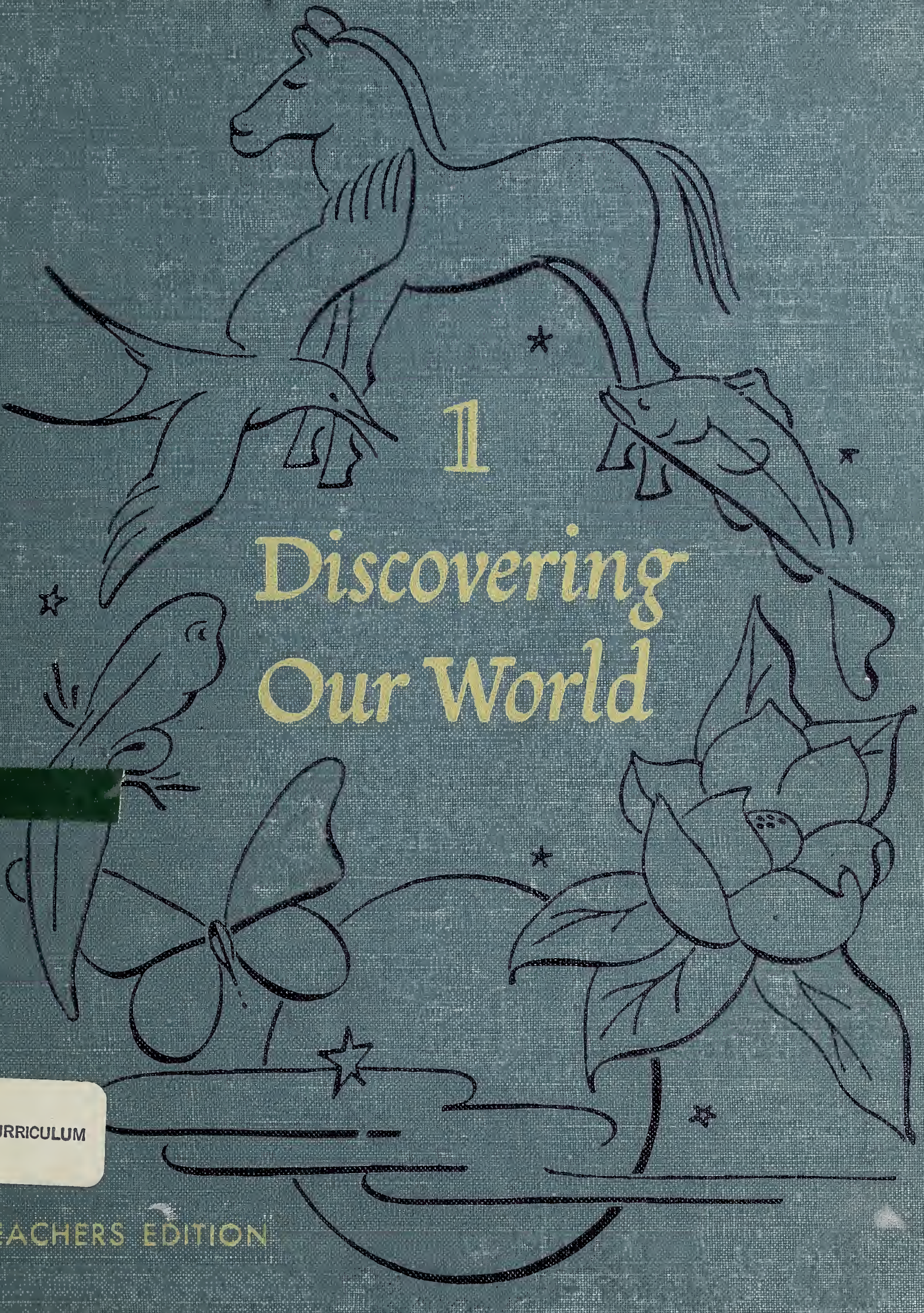
Discovering Our World



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TEACHER'S GUIDEBOOK

FOR

Discovering Our World

BOOK 1

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SCOTT, FORESMAN AND COMPANY

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Contents

PAGE

Preface 4

PART ONE. **Philosophy and Technique** 5

Why Teach Science? 5
Learning and Science Teaching 7
    Conditions for effective learning 7
    The teaching cycle 8
    Organization of this series 9
How to Use This Book 10
    Fitting the book to local conditions 10
    General suggestions for teaching the units 11
        Preparing to teach 11
        General procedures 12

PART TWO. **Suggestions for Teaching the Units** 20

Using the Introduction 20
UNIT 1. How Are the Things of the World Put in Groups? 21
UNIT 2. Why Do All Living Things Need Air and Water? 35
UNIT 3. How Does Your Body Work? 41
UNIT 4. Why Do We Have Days and Nights? 49
UNIT 5. What Can We See in the Sky at Night? 55
UNIT 6. What Can Magnets Do? 62
UNIT 7. How Can You Keep Well? 68
UNIT 8. How Do Animals and Plants Grow? 74

PART THREE. **Bibliography** 85

Supplementary Reading for Pupils 85
For Pupils and Teachers 86
For the Teacher 87

PART FOUR. **Materials and Sources** 90

Care of Living Things in the Classroom 90
List of Materials 94
Supply Houses 95
Visual Aids 95

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Preface

The impact of science on daily life emphasizes the need for an organized science program throughout the elementary grades. A new subject not many years ago, science now occupies an increasingly important place in the curriculum. Experienced teachers have discovered that science is not mysterious. It is no more difficult to teach than other subjects long taught in the elementary school. In fact, the child's natural curiosity about the world in which he lives makes science teaching easy. Motivation is never lacking in a properly conducted science class.

Yet many teachers, untrained in science, are fearful of science teaching. They suspect (often rightly) that pupils know more about science than teachers do. And they tremble at the thought of being asked a question that they cannot answer. These teachers lack confidence because they lack training in science. The purpose of this *Guidebook*, therefore, is to provide in-service training in science teaching. It is designed to help the inexperienced teacher learn as she teaches. Although intended primarily for teachers who lack the background and experience required for effective science teaching, the *Guidebook* also provides much information that will be useful for experienced science teachers.

Part One of the *Guidebook* discusses the philosophy of education and the technique of teaching used throughout the *Discovering Our World* series. It is divided into three main sections. The first section takes up the objectives of science teaching. The second covers the conditions of effective learning, the teaching cycle, and the organization of the series. The third deals with general methods for teaching science effectively. Part Two gives specific suggestions for teaching each unit in the pupil's book. Part Three is a book list. Part Four gives information about the care of animals and plants in the classroom, materials needed for the experiments and observations, and visual aids.

The usefulness of the *Guidebook* will be apparent to teachers acquainted with the books that precede or follow *Discovering Our World* in the *Basic Studies in Science* program. The suggestions have come from years of experience of the authors, their colleagues, and the teachers who kindly helped in shaping the book. The authors will be glad to receive additional suggestions for making this *Guidebook* a more effective teaching aid.

Part One PHILOSOPHY AND TECHNIQUE

Why Teach Science?

Instruction that does not transfer over to life, providing a guide for behavior in the situations that arise, does not function. Therefore, the task of the teacher of science or of any subject is to determine what modifications of behavior can be brought about by that subject. A boy or girl who has studied science should be a different individual from the one who has not studied science.

The problem that every teacher of science must solve is: How can I so teach science that it will function as a way of living, as a mode of interpreting the world in which we live, as a way of reacting to our environment? Science so conceived is not simply a collection of facts about the various forces, materials, and phenomena of nature; it is a method of behavior.

If we analyze the ways in which a study of science will contribute to desirable modifications of behavior, we find five ways in which modification can be brought about.

1. The first way of modifying behavior through science is *by developing a genuine interest in the world of nature and a desire to know more about it.* A prerequisite to this interest is a rich background of experiences with the forces, materials, phenomena, and living things that make up the world in which we live. In this series, the authors have provided this rich background of experiences. They have also suggested activities that the child can carry on to discover more about the world in which he lives. A person who has acquired this interest has a never-ending source of satisfaction.

2. The second way in which the study of science can modify behavior is *through an understanding of the forces, phenomena, processes, materials, and living things that interact to produce the world in which we live.* Learning is essentially a process of acquiring meanings. When a thing, situation, or event has acquired meaning, it is understood. Perhaps the best statement of this idea has been given by Dewey: "To grasp the meaning of a thing, an event, or a situation is to see it in its relations to other things, to note how it operates or functions, what consequences follow from it, what causes it, and to what uses it can be put." Thus, one problem of the science teacher is to discover how the child acquires meanings.

A major type of learning in science is the acquisition of general concepts. Such general concepts cast a flood of meaning over the forces, phenomena, and materials of the environment with which the child comes in contact. Let us take an example. To identify a thing as a member of a certain group is to explain it, or to give it meaning. If we say that a thing is a "living thing," you know in general what kind of thing it is. You know that it carries on certain processes and activities. You know all this because you have acquired a general concept of what a living thing is. By means of such concepts, you are able to generalize, to carry over meaning from one situation to another.

In the teaching of science, we need to keep in mind the development of general concepts —concepts that may transfer to other situations and serve as a method of interpretation and explanation for particular things, events, and situations.

If you have studied science, you know that science generalizations are often stated as principles. For example, "Solids expand when heated and contract when cooled" is a statement of a principle. The principle tells you what happens when a certain condition is present. If you heat a solid (the condition), it will expand (the effect). A principle, therefore, is a statement of the relation between conditions and effects.

Since these principles are general in their operation, they interpret behavior and supply a guide for it in many situations. For example, consider the idea of gravitation. A baby takes a long time to discover the force of gravity. Through experience, he finally discovers that an object will fall unless there is some support beneath it. Then he may take great delight in dropping objects just to see if what happens will meet with his expectations. Finally, he generalizes and arrives at the conclusion that all objects must be held up by something, or they will fall. He has now acquired a method of behavior that enables him to deal successfully with situations in which the force of gravity is operating.

This example shows that a principle of science is not simply a collection of words to be memorized; it is the basis for a method of behavior. A person who understands a principle behaves differently from one who does not. He has a basis for explaining what he sees; that is, he can tell why something happens because he knows the conditions that are necessary to produce the effect which he observes. He can predict what will happen because he knows that certain conditions are followed by certain effects. He can bring about desired results because he knows the conditions necessary to bring them about. A person who understands a principle thus has the necessary basis for planning practical activities.

3. The third way in which modification of behavior may be obtained through science is *by developing the scientific attitude.* There are hundreds of superstitions fastened in the mind of the human race. Most of us are acquainted with people who firmly believe that breaking a mirror or walking under a ladder is a harbinger of bad luck. Probably none of these superstitions taken singly would seriously affect the life of any individual. Nevertheless, such beliefs are symptomatic of a condition that is very serious, namely, the lack of understanding of a most important contribution of science: a conviction of the universality of cause and effect.

A person who has the idea of cause and effect is entirely different from one who lacks this understanding. If he has this idea, he cannot possibly believe in superstitions, palmistry, or fortune telling by cards or tea leaves. All of these false notions fall down when examined in terms of a possible causal relationship.

This conviction of the universality of cause and effect is part of what is known as the *scientific attitude.* The holding of one's viewpoint as tentative until all the evidence is examined, the spirit of inquiry, and the habit of looking for problems to solve are also parts of the scientific attitude. A person in whom the scientific attitude has been developed has a distinct method of reacting to his environment—a method totally different from that of the person with no sense of scientific values.

Every available opportunity should be used to help children acquire the scientific attitude. Toward that end, they should be encouraged to become more observing, to look at a problem from every side before they express an opinion, to experiment carefully and accurately, to demand reliable sources of information, to withhold judgment until there is sufficient evidence to permit the drawing of conclusions, and to react intelligently to superstitious beliefs.

Children are vitally interested in science. As a result, they will ask many questions. This is a valuable part of the scientific attitude for both children and teacher. The teacher should not feel embarrassed if she does not know the answers to all of these questions. No scientist knows the answers to all the questions asked him. Any teacher of science will sometimes need to say to her pupils, "I do not know the answer, but I will be glad to help you find out." In fact, when the teacher knows the answer, she should not always tell it, especially if the question relates to something of basic importance. Rather, the teacher should help the children find the answer.

With such an attitude, the children and the teacher may solve coöperatively problems of mutual interest. A spirit of working together is most highly to be desired. The conclusions then seem doubly important, for the method of solving problems is no less important than the results obtained. Stimulate the pupils to do as much observing as possible. Let them examine things and arrive at their own conclusions. Try always to draw on their previous experience and on their observations made outside of the classroom.

4. The fourth way of modifying behavior is *by training in the scientific method of thinking.* The science class is the place *par excellence* for training pupils to become better thinkers. This is true because the generalizations of science are themselves the product of reflective thinking. It is possible in the science class to retrace, at least in part, the thinking through which the generalizations were reached. By using the experimental method of attack, we can set up situations where certain conditions are present and observe the effects produced. In the science class, pupils can make their own observations, draw their own inferences, and check the accuracy of their own conclusions.

5. The fifth way of modifying behavior is *by developing skills such as making observations, doing experiments, interpreting pictures and diagrams, reading science content with understanding, reading source materials,* and *using the instruments of scientists.* The *Basic Studies in Science* program includes a wide range of activities that are basic to the study of science. These are graded in difficulty so that each book in the program makes use of skills taught in earlier grades and then carries them on to higher levels of understanding and increased ability in their use.

Learning and Science Teaching

Conditions for effective learning

Methods of teaching must necessarily be based on the findings of psychology that deal with the learning process. These findings may be thought of as principles of learning that show the teacher what she must do to provide the conditions for effective learning. A brief statement of these principles and their application to methods of teaching science follows.

1. *Learning is most likely to occur when a child has a definite purpose to accomplish.* Instruction in science should be focused on a functional understanding of the generalizations of science that make the world meaningful. Somehow or other, we must make the acquisition of this understanding important to the child. It must meet some need that he has. Its acquisition must result in some satisfaction to the child. In other words, the understanding must solve some problem that he wants to solve, answer questions that he wants answered, or show him how to do something that he wants to do.

Application of this principle of learning must be made when starting a new unit or a new problem. It is a matter of setting the stage for learning. There are various ways of doing this. See pages 12-14 of this *Guidebook.*

2. *Activities must be set up that produce some active response by the child.* In science, we are concerned with certain understandings. We are trying to teach certain concepts that will help the child in his adjustment to the world in which he lives. Now a person cannot just learn an understanding. An understanding is obtained only when he does some thinking. Furthermore, if he acquires an understanding, it must be a product of his own thinking. We are all familiar with the saying, "We can't learn pupils, we can only teach them." In other words, as teachers, our task is to set up a learning situation in which pupils carry on certain activities focused on the understanding. The

pupil learns as he carries out the activities. The understanding that results is the pupil's. It is a product of his own activity. What the pupil does, therefore, determines what learning, if any, will occur. In general, the more active the participation of the pupil in deciding what should be done, the more purposeful the activity will be and, therefore, the more likely it will result in the desired learning product. The types of activities will vary with the learning product to be attained and with the kinds of materials available in the classroom.

This *Guidebook* is concerned primarily with the more effective use of the textbook. Suggestions for setting up desirable activities using text materials with different types of organizations will be found on pages 14-16 of this *Guidebook*. There are also many suggestions for doing experiments, taking field trips, etc. These suggestions will be found for the most part on pages 13-16 of this *Guidebook*. A discussion of "Using the pictures in the book" will be found on pages 17-18.

3. *Learning, to be effective, must be based on the experiences that the child has had or is having.* This implies that new concepts must be based on an adequate background of first-hand experiences. The more closely related the first-hand experiences of children are to the concept that is being developed, the more meaningful the concept will be. This principle is especially important in starting new units or new problems. Suggestions for its application are given on pages 12-14 of this *Guidebook*.

4. *The learning activities must be adapted to the individual needs of the child.* This means that a wide variety of activities should be carried on. Different activities attack concepts from different angles and thus obtain greater depth of meaning. Furthermore, some methods of development are more effective than others for different children. Reading, doing experiments, making observations, interpreting pictures, planning ways of finding out things, etc., call for different types of thinking. A many-angled approach is most likely to provide activities that are appropriate for children with different interests and abilities. Suggestions for different types of activities are included on pages 12-19 of the *Guidebook* and also in the procedures suggested for each unit.

5. *Learning, to be retained, must be used.* This principle has two implications. In the first place, it implies that activities must be set up which require the pupil to use the concept as a basis for explaining things around him and as a guide for practical activities. Only through use does the child acquire an understanding and the ability to use this understanding in his daily life. The more closely the kind of activity set up is related to the kind of situation that is met in daily life, the more likely it is that the learning will transfer to daily living.

In the second place, the principle implies the necessity for constant use of the concept and its reinterpretation in the light of new experiences. Old concepts must be constantly related to new concepts so that a continuous reconstruction of experience can take place.

In the pupil's book, common situations in the lives of children are used to introduce children to the problems. The examples applying the concepts are also of this type. In this way, the concept is related to life itself. Questions that children usually raise about the concepts are raised. Then the children are shown how to use the concepts to answer these questions or to do other things. The teacher should know what kinds of questions to ask children. Various types of questions will be found in the discussions of the different kinds of activities on pages 12-19 of the *Guidebook*.

The teaching cycle

The teaching cycle, to be effective, must parallel the method of thinking to be used in the learning cycle. It must insure that the child actually follows through the steps in thinking. This is done by setting up appropriate activities in each step of the cycle.

The principles of learning may be made more specific by showing how they are applied in teaching a generalization of science.

1. *There must be a stimulus to initiate learning.* In science, the stimulus must present a problem, because an understanding is obtained only through thinking. To present a problem, the situation must be meaningful to the learner; that is, it must be connected with some experience he has had or is having; and the situation must be sufficiently concrete and interesting to challenge the pupil to find a solution. Solving the problem is the purpose in the mind of the child. Ways of raising problems in the minds of pupils are discussed under "Starting a new unit or problem," page 12 of the *Guidebook*.

2. *There must be a period of assimilation or experience getting.* Pupils are sent to their textbook and other books, experiments are performed, field trips are taken. In fact, all sources that will supply needed facts and experiences are used. This period will always culminate in activities that require the pupils to generalize. Suggestions for using the book, performing experiments, and carrying on other activities are included on pages 12-19 of the *Guidebook*.

When a pupil has made the generalization, he has arrived at the point where he catches the idea; that is, he sees the relationship vaguely. If left at this point (and many teachers allow this to happen), he has not attained real learning. Therefore, the next step is extremely important.

3. *The generalization must be made meaningful.* This is a period of teacher-pupil activity in which the teacher tries to show some of the applications of the generalization: (1) how to use it, (2) where it is used, and (3) when it is used. In the text, applications of the generalization follow the development of the generalization. They take the form of new examples or problematic situations that are solved by use of the generalization. The specific suggestions for each unit provide additional examples to help make the generalization clear. This concludes the part of the teaching cycle in which the aim is to get across the understanding.

4. *Practice in the use of the new understanding must be provided.* The pupil must be provided with situations in which he uses the generalization for predicting, planning, and explaining. Since the understanding does not function unless it transfers to daily life, the situations must be common in the environment of the child. The greater the number of these situations, the more likely that the generalization will be functional in actual life. The questions at the ends of problems and units help provide these situations.

As a result of this step, the pupil arrives at a point of functional understanding. He can now use his understanding in situations appropriate to his level of development. In other words, he has arrived at a point of intelligent behavior. This method of developing a functional understanding is the method of thinking used by anyone who really carries on a complete act of thought.

Organization of this series

The *Discovering Our World* series is the result of a definite demand from teachers for a well-balanced, organized course in science, focused on acquiring meanings that will function in intelligent living. It is not just a collection of facts about bees, butterflies, and beavers. Interesting though these facts may be, they are not sufficiently general in their meaning to provide a basis for explaining the world or for solving our everyday problems.

In this series, the content is definitely focused on the acquisition of general meanings. These general meanings are developed by the problem method of attack. Problems, or questions, arise from, and thinking starts with, doubt or perplexity. A person has something to do or something that he wants explained; but he does not know what to do or how he can explain away his perplexity. This starts his mind searching for a way out of his difficulty. He begins to think. In general, the pattern of effective thinking is as follows:

1. Recognizing the problem to be solved.
2. Recalling experiences that may help to solve the problem.

3. Searching for new facts that may bear on the problem.

4. Evaluating the suggestions that come to mind and selecting the one that appears most promising.

5. Testing the suggestion for its truth.

6. Drawing a conclusion and testing the conclusion for its truth in other situations.

If study materials are to help pupils do better thinking, the materials must be organized and the ideas developed in such a manner that they follow this general pattern of effective thinking. For this reason, the problem method of attack has been used throughout the series.

Each unit deals with a major problem in the environment of the child. The unit, or major problem, is then broken down into minor problems. The solution of each minor problem is essential to, and leads toward, the solution of the major problem of the unit. A glance at a unit and its subdivisions in the table of Contents (pages 3-5 of the pupil's book) will show this. The child is confronted with a major problem. To solve this problem, he must think through minor problems. As he acquires an understanding of the generalizations and principles involved in each minor problem, he is building up an understanding of the major problem of the unit.

Each new idea in *Discovering Our World* is presented in such a manner that it becomes a problem for the child to solve. The text says to the young learner, "You have seen this happen, or you have had that happen to you. Now let's see if we can find out why it happened. First of all, just what did happen, and what were the conditions under which it happened?" This is no didactic, passive approach to learning. It is a pupil-activity, problem-solving approach: "Let's do something to see what we can find out in answer to our question." That is the spirit and the method of presenting and developing new ideas in the *Discovering Our World* series.

This treatment of science principles leads the child inductively, by experiments and observations, toward the acquisition and understanding of the principles. At every step, the spirit of problem solving, the spirit of discovery, is maintained. The organization, pictures, experiments, observations, exercises, and activities in the books of this series are focused on two objectives: (1) the development of meanings and (2) the development of better methods of thinking. This focus is maintained by a teaching technique based on problem solving. A child cannot *memorize* his way through these books; he must *think* his way through them.

How to Use This Book

Fitting the book to local conditions

The pupil's book includes enough material for those schools where full time is allowed for science as an established part of the curriculum. In such schools, the pupils probably will cover all of the units, including the questions and activities suggested. They may further enrich the science course by doing outside reading and engaging in additional activities according to their own interests.

In many school systems, science is introduced in the first grade. Children will, therefore, have many concepts that contribute to the understanding of the concepts presented in the text. To assist teachers in discovering this background, the authors have listed at the beginning of each unit, the background units found in the earlier books of the *Basic Studies in Science* program. Reference to these books will give teachers an idea of the experiences on which they can build the new concepts. Teachers are urged to become familiar with the concepts taught in preceding grades. In many cases, recalling these earlier experiences will bring about a decided saving in time. Furthermore, it will help pupils reinterpret these earlier experiences in the light of the more comprehensive concepts presented in the later grades.

In schools where time is limited, it may be necessary to shorten the course somewhat. This can best be done by covering some units rapidly, without stopping for detailed development, while others may be more carefully developed with all the suggested activities carried out. However, it is not wise to omit units or parts of units. A unit that is unrelated to others within a book may be necessary for the understanding of concepts presented in later books. For example, in Book One the unit on magnets (Unit 6) is not related to other units of Book One. But an understanding of magnets is presupposed in the unit on energy (Unit 2) in Book Two and in the unit on electric current (Unit 5) in Book Three. The section "Science background" in Part Two of the *Guidebook* shows the interrelationships of the units in the series. The series has been carefully planned as part of an organized program in science and is most satisfactorily used as such.

General suggestions for teaching the units

Many teachers have had little or no experience in teaching science. Yet science is not difficult to teach. First of all, children are vitally interested in science. This, of course, means that half the battle is won. The method used in teaching science is not greatly different from that used in other subjects where understanding of certain concepts is the goal. However, science teaching makes greater use of observations, field trips, and experiments than is ordinarily made in other subjects. The science activities in the middle grades are very simple. The equipment consists of easily available materials. The directions given in the text, together with pictures that show the materials used and how they are put together, are so detailed that a teacher who knows little or nothing about science will have no difficulty in doing the experiments or carrying out the other activities.

Needless to say, the ideal learning situation is one in which the teacher enlists the active coöperation of her pupils in planning and carrying out the activities of the various units. The following general suggestions will be helpful in achieving this ideal situation. (Specific suggestions will be found in Part Two of the *Guidebook*, which deals with individual units.)

1. Interest pupils in an active program of observing and collecting as much material as possible from their surroundings.
2. Encourage boys and girls to suggest additional experiments, field trips, and observations.

In this section of the *Guidebook*, the authors have set up general principles for using the book and for carrying out the types of activities suggested in the book. These general principles should be applied in teaching specific units. Once a teacher understands the general principles and sees how they are applied in concrete situations, she will soon gain skill in applying the principles in new lessons. Of course, many teachers do not need a discussion of this type. This section is written especially for those teachers who are a little uneasy about their ability to teach science.

Preparing to teach

First of all, the teacher must have clearly in mind the science generalization that she is trying to teach. She can use the list of concepts in Part Two of this *Guidebook* to find out what these important generalizations are. As she uses the text, she must learn to differentiate between the facts, examples, and other assimilative materials and the generalization itself. An inexperienced teacher may easily fail to do this. Therefore, she does not see that the text is focused on getting across a certain concept. As a result, the activities set up in the classroom lack focus because the teacher has none. As a first step in preparing to teach, therefore, the teacher should find out what is the big idea, understanding, or generalization that she is supposed to get across. To help her see what the general concepts are, the authors have listed them at the beginning of each unit. In addition to this, the authors have listed the concepts for each subdivision, or problem, of each unit.

With her *Guidebook* open to these lists, the teacher should read through the unit as a whole and again through each problem before presenting it. She will then have a clear idea of the scope of the unit and also of the contribution that the concepts in each problem make to the unit as a whole. She will also have a clear picture of the relation of the observations, experiments, and other activities to the development of the concepts. She will be able to plan ahead for time and materials when necessary. Specific suggestions for planning ahead will be found in the sections called "Procedure" in Part Two of the *Guidebook*.

During the initial preparation for teaching the unit, the teacher should also look ahead to the additional activities suggested in the "Things to Do" sections at the ends of the units. Some of the activities are related to the unit as a whole. Others pertain to certain problems and are referred to in the procedure for the problem. Since it is better to use these activities throughout the unit rather than to wait until the unit has been completed, the teacher should look ahead and plan for the ones that she can use.

Second, the teacher must find out what experiences the children have had that can be explained by the concept. By questioning the class, the teacher should be able to discover just how far the pupils have advanced toward an understanding of the concept. However, if they have had no appropriate experiences, the concept cannot be taught until such experiences have been acquired. An experiment, observation, or field trip will often provide the needed experiences.

Because of the limited science training of many elementary teachers, the authors have included some of the technical science background behind the elementary presentation of the text. This will be found in the sections entitled "Information for the teacher" in Part Two of the *Guidebook*. Teachers should also consult standard high-school texts in biology and general science. These will give the desired information without going into needless technical detail. They will also give some additional background as a preparation for teaching the unit.

General procedures

Starting a new unit or problem

The first teaching situation met in a new unit or problem is naturally that of deciding how to get started. Shall I have the pupils read the introductory section first? Shall I raise some questions before sending them to the book? If so, what kinds of questions shall I ask? Shall I start with a field trip or a demonstration? Shall I tell them a story? What shall I do?

As pointed out earlier in this *Guidebook*, learning begins when the pupil starts to think. His thinking starts when he is faced with a situation in which he is not certain of exactly what to do or when something happens that he does not understand and he wonders "Why?" or "How?" In other words, thinking starts with a doubt or perplexity. There must, however, be more than a perplexity; the pupil must also want to do something about it.

All of this means that the pupil must have a question before he will begin to think and that he must want to answer this question. To start a new unit or problem, the teacher must be certain that the pupil has questions which he wants answered. He may want to find answers to his question because he sees their use value or because they provide for some definite need or simply because his interest is challenged and he wants to know. Any of these reasons are equally good for raising questions. The important thing is to be certain that the child has some questions which he wants answered.

Questions arise when a person is in doubt. No concrete question can arise, however, unless it is related to some past experience or present experience. This is true because the meanings that we have are the results of our experiences. Without experiences to give us meanings, we cannot have questions because we do not know enough. We can only be confused. We cannot put our finger precisely upon the perplexity, and so we cannot start to think. To start a new unit or problem, therefore, the teacher must relate the unit to past experiences of the pupils or to experiences that they are now having. These experiences must lead into questions that the children cannot answer. Here are some of the methods in which a new unit can be started. (Most of these methods can also be used to start new problems within the unit.)

1. *Ask questions about experiences that the pupils have had which may be related to the unit.* To use this approach, first make a list of what children have probably seen, heard about, read about, or done. Then ask questions such as: "Did you ever see——?" "What did it look like?" "Have you ever heard about——?" "Did you ever make a——?" "Did you ever watch someone——?" The purpose of these questions is to get some facts from the pupils' past experiences. The questions will also bring to light experiences that the pupils would never voluntarily recall because they would not see the relation of the experiences to the new unit.

Now you are ready to raise questions. Accordingly, ask questions about the "how" and "why" of these experiences. "How do you explain this?" "What made this happen?" "Why did you do——in this way?" Use questions such as these to push the pupils back further and further until you come to explanations that they cannot make. Write on the board questions that they cannot answer under the heading *Questions We Cannot Answer*.

With these questions in mind, the children can read the introductory section of the unit to see if they can find any answers to their questions. Often the introductory section raises new questions. If the children cannot answer them, they should be added to the list on the board. (Example: Unit 2, pages 47-48.)

2. *Compare experiences of pupils with experiences presented in the text.* The introductory sections of some units present experiences that are used to raise questions. If children have had similar experiences, ask questions about them. Have the children tell how they did a certain thing or describe something they have seen. If a series of steps is involved, write them on the board.

Then refer children to the book and say, "Here is a story that tells you how someone else did this." Have pupils read to find out what was done. Tell them you are going to ask them to tell the class, step by step, what was done. Write these steps on the board. Then have pupils compare these steps with the steps that they have listed. Then ask for reasons for the various steps. This should result in questions that the pupils cannot answer. (Examples: Unit 1, pages 9-10; Unit 3, page 67.)

3. *Use pictures to start discussion of the unit.* Have pupils read the unit title. Then ask questions about pictures in the unit that will lead into the first problem. (Example: Unit 7, pages 157-181.)

4. *Have pupils read the unit title.* Then ask them to read the problem titles to find out what kinds of questions are to be answered. Write the problem titles on the board and ask pupils what they think the answer to each one is. This procedure will help create interest in the unit and at the same time will give an idea of the scope of the unit; it may be used with almost any unit. (Example: Unit 4, pages 91-111.)

5. *Use the introductory section to initiate activities that will result in a question.* In some of the units, the introductory section sets up activities that will raise questions. The text describes how a class went about finding an answer to a question. First, have pupils read the unit title. Then tell them that the introductory

section tells what one class did to get started. Have them read the section to find out what this class did. Next, ask questions about what this class did. Then have the pupils plan how they can carry on the same activity. After the materials have been brought in, raise the questions to be answered in the first problem. The pupils should now be asked to tell what they think should be done to answer the question. Then compare this solution with the method suggested in the text. (Example: Unit 1, pages 9-10.)

6. *Do some experiments.* (These can be experiments suggested by the book or experiments not in the book. The purpose is to raise some questions.) A good way to start a unit is to get some facts that require explanation. This method is often used in the text. Have the pupils read the unit title. Then tell them that the introductory section tells how to do an experiment to get some facts. Ask them to read the section to find out how to do the experiment. Next, have the children tell how to do the experiment or have some member of the class do the experiment. Then make a list of the facts brought out by the experiment. Call for explanations of these facts. Make a list of questions about facts that cannot be explained. (Example: Unit 6, page 139.)

7. *Take a field trip to get some facts to explain.* Whenever possible, the pupils should get facts by first-hand observation. Since the units in this book are related to common environmental situations, children can often be taken on walks or trips where they can make observations and thus get facts that call for explanation. To find out what to observe and what kinds of questions to ask, read the problems of the unit and note the pictures and their legends. Then take a walk yourself to find out what things can be seen. Make a list of the things and the questions you can ask about them. (Example: Unit 8, page 183.)

Using the text to get ideas needed to answer questions

In general, the text uses three methods of organizing the study material: (1) It may tell how one class answered the question. (2) It may answer the question by telling the pupils how to carry on certain activities. (3) It may answer the question by straight exposition. The method of using the text will necessarily vary with the method of presentation used in the text.

1. *The text presents a class discussion.* In this type of presentation, the text presents a running account of a classroom discussion. This method is used principally in the opening unit of the book to show how a science class might be conducted. The teacher asks and answers questions; pupils answer questions and ask questions; the teacher guides the discussion toward an understanding of the concepts that she is trying to get across by her questions and her follow-up of the pupils' answers. This type of presentation has several purposes.

First, it presents a pattern for carrying on a discussion in a science class. Teachers who have had no experience in teaching science will find it profitable to read through several lessons of this type to get a better idea of the kinds of questions asked by the teacher to keep the discussion going and the ways in which the pupils are brought into the discussion. Note that the pupils are asked to suggest ways of doing things and that these ways are discussed and evaluated by the pupils.

Second, the children, as well as the teacher, must learn to participate in a classroom discussion. Unit 1 is developed largely by this method so that pupils may be introduced to the type of thinking that goes on in a science class. The teacher might well say, "The class described in our text is carrying on a discussion. Let's see how they do this so that we'll learn how to discuss, too."

Third, presentation of this type adds interest to the text because children are interested in what other children do. They are also interested in carrying on the types of activities suggested in the text.

Fourth, this type of presentation permits a slow and easy development of the concepts.

Each step in the development of the concept is included. The children can easily follow the thinking of the class and see how the class arrived at the concept. There are several methods of using this type of material; the method to be used depends on the way in which the material is developed and the purpose.

a) The purpose is to initiate an activity in the class. To do this, the text describes what one class did. For example, let us suppose that pupils have brought various kinds of things to school. The teacher raises a question, "How can we find out more about these things? Let us see what the class in our text did." After the pupils have read the text to find out what the class did, the teacher asks questions such as: "What was the class trying to find out?" "What did they do to answer the question?" "Why did they decide to do this?" "Could we do this?" "How could we do this?"

As can be seen from the questions, the major purpose is to show the pupils what they can do. The suggested activity should be carried on whenever possible. While it may be possible to get an understanding merely by reading and discussing the text, there is no substitute for actual experience. Note that the questions asked by the teacher call for more than repeating what the text says. They raise questions about the "how" and the "why" of the activity. (Example: Unit 1, pages 10-11.)

b) Sometimes it is better to raise a question and either suggest or have the pupils suggest what they might do to answer it. Then have the pupils go as far as they can in answering the question. The children can then be referred to the text to find out if the class described answered the question in the same way or in a different way. Then have the children find the ways in which their answer was like or different from what the class in the text found. (Example: Unit 1, pages 12-18.)

c) As a rule, pictures are included that show how the class described carried on the activity or that show the finished product of their activity. The teacher asks questions such as: "What is the class doing?" "Why are they doing this?" "Can we do this?" "How did they do this?" before the pupils read the text. Rediscussion of the pictures on the basis of what the pupils find out can follow. (Example: Unit 1, pages 44-45.)

2. *The concepts are developed by raising questions and answering these questions by making observations and doing experiments.* Science differs from the other subjects studied in the elementary school in that the questions which arise can be answered by observation and experiment. Through the use of these two activities, the pupils can get first-hand information. They can then base their thinking on facts that are meaningful to them. Throughout this book, experiments and observations have been introduced wherever possible. This has been done for two reasons: (1) because all learning focused on understanding must be based on a background of perceptual experiences, that is, on information that the pupil can get with his own senses; and (2) because pupils should acquire the attitude, "If we have questions or want to find out about something, we can do experiments (or make observations) that will answer our questions."

Experiments and observations are introduced in this book to provide facts that are needed to answer some questions. A statement in the text is made more meaningful by doing an experiment or making an observation. Or the experiment is done or the observation made to answer a question that has been raised in the text just preceding the experiment.

Before the text is read, the teacher should (1) raise questions about past experiences of pupils such as were suggested in the section dealing with starting a new unit and (2) raise the question that the experiment or observation is to answer. Then ask the children, "How can we do an experiment to find out?" (It is always good practice to have children suggest possible ways of doing an experiment. Many of them may be good enough to try.)

Now that the question is raised, the children can be referred to the book for directions. The teacher can say, "Our book tells us how to do an experiment to answer our question. After you read the directions, I am going to ask you to decide what to do." Write *What to do* on the board and then have the children tell what directions to write.

Make the directions as brief as possible. If a simple diagram can be made, have pupils tell how to make the drawing. If they do not know, show them. This is valuable because pupils have to learn how to interpret diagrams. Practice in making diagrams will help them learn how to interpret diagrams.

Now ask the pupils what they think will happen. Get them to predict. This is effective because (1) you can ascertain from their answers whether or not they understand what is going to be done; (2) you can see if they know what to look for; (3) you can make them commit themselves and make them interested in seeing whether they are right or wrong.

Next, get them to understand what the experiment will show if a certain thing happens when the experiment is performed. Ask them, "If——happens, what will this show?" Then do the experiment. Write on the board *What happens*. Have the children decide what to write. Then raise the question, "What does this seem to show?" Write *What the experiment shows* on the board. Have the children tell what to write.

Whenever possible, the step of verification should be used. Ask, "Is there any experiment we can do to prove that we are right?" In many cases, such an experiment is included in the text. If this is the case, have the children read the experiment and record the results under the steps already listed. Then have the children work out a conclusion. The conclusion should answer the question and give reasons for the answer.

After all of the experiments have been performed, raise the questions, "What facts do our experiments give us that we can use to answer our question?" "What facts does the book give us?" The facts from both sources should be incorporated into the answer for the problem. (Example: Unit 2, pages 48-49.)

3. *Concepts are developed by raising questions and answering these questions through presentation of reading material of a descriptive nature.* Whenever possible, experiments and observations are used to develop the science concepts. Sometimes, however, it is impossible to provide experiments that are sufficiently simple to be carried on by middle-grade children or that do not require laboratory facilities beyond the resources of the elementary school. It is equally impossible to provide for actual observation of all living things in their natural habitats. Accordingly, the text must provide factual material based on the observations of scientists. It should be emphasized that the facts have been acquired by experimentation and observation. This point of view can be developed by asking such questions as "How do you suppose that scientists found out about this?" "What might we do to prove this?" "Why can we believe that this is true?"

The method of developing the concept, of course, depends on the kinds of concepts that are being developed. For example, if the content is focused on showing the children how some device works, the development will be somewhat as follows: (1) what the device does, (2) how it is put together, (3) how it is made to work, and (4) an explanation of what happens when the device is operated. If the content is focused on the development of the characteristics of a group of living things, materials, etc., various members of the group are described; and then the characteristics common to all members of the group are discussed. If the concept is focused on some relationship, specific examples of the relationship are presented; and then generalizations are made about this relationship.

The pupil's book provides the necessary information. It should be pointed out here that the facts included in the book are a means to acquiring the concept. The ability to repeat verbatim what the book says does not necessarily mean that the child has acquired the idea. Suggestions for developing the concepts are found under the heading "Procedure" in each problem of the *Guidebook*.

Using the pictures in the book

In *Discovering Our World, Book One*, as in all the books of the *Basic Studies in Science* program, the pictures are functional. They are an essential part of the method of developing the concept. Each picture has a definite purpose to serve. For example, some pictures are used to raise questions, some are used to show steps in a process, some are used to show how an experiment should be performed, some are used to supply additional applications of a process, and some are used to provide for practice in interpreting. Pictures may be a substitute for the actual experience. They make it possible for the child to experience vicariously the experiences that others have had. They bring the near and far environment into the classroom.

To use the pictures effectively, the teacher must study each picture to see how it can be used to assist in learning. First, she should understand what the purpose of the picture is. Then the question is, "How can the picture be used for this purpose?" This is a matter of determining what questions to ask about it or what activities to set up that will make the picture serve its purpose. The following examples show how to use pictures in this manner.

1. *Using pictures to raise questions.* Pictures used for this purpose usually have the legend in the form of a question. The problem may be introduced by asking pupils to look at the picture and answer the question. Then they may be directed to read the problem title and the text to find out if their answer to the question was correct. The original answer can then be corrected in light of what they have found out from their study. If the original answer is incorrect or partially incorrect, the children should be asked why it was incorrect. (Examples: Unit 1, pages 15, 17, 19.)

2. *Using pictures to show how to carry on some activity.* The text describes an experiment to perform or an observation to make. The picture shows some children carrying on the activity. The purpose is to help pupils see how the activity is carried on. There are several ways of using these pictures.

a) Have the children read through the directions in the text. Then refer to the picture. Ask questions such as: "What things is the boy using?" "What is he doing?" "What is he trying to find out?" "Can we do this experiment?" "What shall we do?" (Example: Unit 2, pages 48-49.)

b) After the question is raised, have the children look at the picture before reading the text for directions. Then ask questions such as those above. Then have the children read the text to find out more exactly what the boy is trying to find out, what materials he needs, and what he is doing. (Example: Unit 6, page 139.)

c) Sometimes the materials and equipment in the picture may not be available in the school. In this case, the picture can be substituted for the direct experience. In some cases, other kinds of materials or equipment can be used. Ask children how they might do the experiment with other equipment that is available. (Examples: Unit 2, page 57; Unit 4, page 97; Unit 6, page 146.)

Often the pictures merely show the apparatus needed and methods of constructing the apparatus. It is necessary to refer to the text to find the directions for doing the experiment. Ask questions such as: "What do we need to do the experiment?" "How shall we put the parts together?" "What do the pictures tell us to do?" Examination of the picture should be followed by having the pupils read the text to check the information that they get from the picture. (Examples: Unit 6, pages 145, 151.)

3. *Using pictures to make graphic a concept developed in the text.* Without a picture, description is often difficult to understand. Pupils cannot always visualize what is described. Pictures also make it possible to show things that the child has not experienced or could not experience in his everyday environment. For example, the pictures on pages 12 and 13, Unit 1, show the sequence of events. Questions about

the pictures should connect what is shown to the concept. Questions such as the following can be used: "What do these pictures show?" "What does the book tell us about these pictures?" "What do these pictures show about plants?"

4. *Using pictures to obtain interpretation on the basis of a concept that is presented.* An essential part of all learning is use of what has been learned. Use of a concept in the interpretation of a picture helps make the concept more meaningful. Many pictures of this type are included in the book. Usually there is a legend with a question. Or a question may be included at the end of the problem. (Examples: Unit 1, page 14, No. 4; page 15, legend under picture; page 16, No. 3; page 17, legend over picture; Unit 5, page 123, Nos. 2 and 3.)

Without the use of pictures, it is almost impossible to teach how a device is constructed. Children find it difficult to visualize a long description of the parts of a device and the relation of these parts to each other. The following questions will help pupils analyze the device and see how it works: "What is the name of the device?" "What does it do?" "What are its parts?" "About how large is a real device of this kind?" "When this part moves, what does that part do?" "What are the different steps in its operation?" "What happens in each step?" "How can we explain what happens?" "Where is this device used?" "Who uses a device such as this?" "Have you ever used a device like this?" "What for?" "How should the device be taken care of?" (Examples: Unit 6, pages 151 and 152.) Pictures of parts of the body and how they work are used in this way also. (Examples: Unit 3, pages 74, 79, 81.)

Using the questions at the ends of problems

The questions found at the ends of the problems also are focused on the important concepts. The final step in each problem is to have the children answer the questions raised at the beginning of each problem. Usually, it is worthwhile to write an outline answer on the board. The outline should be developed by the children. In general, it should correspond closely with the outline of concepts presented in the *Guidebook*. If children fail to include a certain concept, the teacher should raise questions that will bring out the concept. For example: "You remember we read about——. What does this show? How do these facts help us answer our question?" Or the children may be asked to reread some part of the problem and the questions above may be asked.

The activity at the end of each problem is a generalizing activity. The children must be led to see that the facts presented in the book are important because they enable the children to get ideas about things that can be used to find out more about other things. For example, when the pupils find that mammals have certain characteristics, these characteristics tell them about other mammals and also help them decide if a certain animal is a mammal.

The questions at the ends of problems are of two types. The first of these two types is designed to test the child's understanding of the study material. Questions of this type can be answered if the child understands what he has read. They correspond roughly with the questions used to test reading comprehension in standardized tests. The second type of question calls for some thinking on the part of the child. It may require the recall of experiences similar to those presented; it may call for classification of objects or events based on certain group characteristics; it may call for the interpretation of a picture on the basis of some concept that has been studied; it may call for comparisons; or it may call for reasons for carrying on an activity in a certain way. These questions are designed to give the children practice in the use of the concept.

The questions may be used in several ways. After the problem title has been read, the children can be referred to the questions at the end of the problem to find out what they must be able to answer after they have studied the text. It is often desirable to have them try to answer the questions before the text is studied. After studying the text, they can compare their original answers with the ones that they now give. This method of study shows the children that they have learned something; they can answer questions that they could not answer before.

Or the text may be studied before reading the questions. Then read the first question to the children and call for an answer. This may be given orally or sometimes in writing. The teacher should distinguish between the information-type questions and the application-type questions. Children are accustomed mainly to questions that can be answered directly by the recall of something which they have studied. When an application-type question is asked, they should be told that they will have to think out the answer because it is not in the text. Occasionally, when they cannot get started on the answer, the teacher may have to ask them what they learned from their study. This might be written on the board. Then say, "How does this help us answer our question?" They must understand that what they learn can be used to answer other questions.

The information-type questions at the ends of the problems can also be used as a basis for a summary. First, write the problem title on the board. Then call for the answers to the questions. Write the answers on the board as briefly as possible. Then help the children condense the answers to the different questions into a single answer to the problem.

Using the "Questions to Answer" at the ends of units

The "Questions to Answer" at the ends of units are so stated as to require a broader association of meanings than is called for by questions at the end of each problem. They call for integration of ideas obtained from different problems and for interpretation of situations on the basis of ideas obtained from the whole unit.

The "Questions to Answer" should be discussed after the problems of the unit have been completed. Children should learn to give evidence for their answers. One method of stressing this is to have children be prepared to cite references in the text, which they used as a basis for their answers. When they start finding the answers to the questions, tell them to look back through the unit and find a paragraph, a sentence, or a picture which they can use to prove that their answer is correct. Then ask them how this reference in the text can be used as proof for their answer.

Since some of the questions are of the application type, children may sometimes have difficulty in answering these questions because they fail to see the connection between the text and the question. If this happens, refer them to the part of the text dealing with the idea basic to the solution. Have them read it over and then ask, "How can we use this idea to help us answer our question?" Every question in the book can be answered by using what the children have studied.

Using the "Things to Do" at the ends of units

The "Things to Do" at the ends of units suggest activities that make more meaningful the ideas in the units and bring about a closer tie-up with the environment. Usually, the activities should be assigned to individuals or groups on a voluntary basis. Some time should be spent in class, planning how an activity should be carried out. This should be as nearly pupil activity as possible, for the planning has the greatest value. Sometimes a group can be instructed to plan what they intend to do and then report back to the class on their plans. Then the plans can be evaluated and changed by the children. In this way, all the children will learn how to plan science activities; and they will get a better insight into the method used by scientists.

Part Two SUGGESTIONS FOR TEACHING THE UNITS

This part of the *Guidebook* gives specific information and suggestions for teaching the individual units. If the teacher has read Part One carefully, she has become acquainted with the general suggestions for handling the various types of teaching situations that will arise in teaching the units. As she comes to these situations (starting a new unit or problem, doing experiments, etc.) she should refer to the appropriate section in Part One. Application of these general suggestions, together with the specific suggestions that are given for the section being studied, will help the teacher approach the situation with confidence.

Using the Introduction (Pages 6-7)

Pupils frequently associate science with an indefinite conception of a laboratory of mystical containers full of liquids that change colors, foam when they are brought in contact with each other, or cause exciting explosions at the slightest pretext. The first few science periods might well be spent in letting pupils express themselves on such questions as: "What do you think science is about?" "What do you think a scientist does?" "Do you know any important things that scientists have discovered or invented?" "How can anyone in our class ever become a scientist?" "What kinds of things do scientists study?" The picture on page 6 and the question at the bottom of the first column will give the opportunity to bring out the basic idea to be stressed throughout the study of this book, namely, that science and subjects for scientific study are in the world all about us in our everyday life.

Then have the pupils read pages 6-7 and ask such questions as these: "Have you ever looked through a telescope or a microscope?" If any class member has had such an experience, let him relate it to the class. "Do you know of anyone who has studied a great deal of science?" Pupils may tell of various adult acquaintances of theirs, or parents or older brothers or sisters, who have studied different phases of science. This may lead up to the discussion of these problems: "What different kinds of things do you think scientists study?" and "How is their work different from other kinds of work?"

This last question may lead into a discussion of the second and third paragraphs on page 7. Bring out the fact that with a scientist, it is *how* he studies or attacks a problem that is important rather than *what* he studies. This method of study or of solving problems is an important habit to form whether one is going to be a scientist or not.

Following this, the teacher may approach the study of the book in some such manner as this: "Our book tells us some of the different things that scientists have found out. It also tells us how they found out these things. There are two easy ways for us to find out what we are going to study. We may look at the table of Contents, and we may look through the book and see the chapter headings and pictures." Thus, interest is aroused in what is to come.

UNIT 1. *How Are the Things of the World Put in Groups?*

Purpose and scope

The purpose of Unit 1 is to give the child an orderly acquaintance with some of the living and non-living things that constitute his environment. Through an elementary study of certain of the major plant and animal groups, the child is introduced to the scientist's method of organizing knowledge. Since this is the main purpose of the unit, no attempt has been made to go beyond the major divisions of the plant and animal kingdoms.

It is important that the pupil understand the meaning of the word *structure* and that he fully comprehend the significance of structure in studying and classifying plants and animals. The idea that living things have parts and that these parts are different in different species is fundamental. It is probably a new idea to children that every living thing in the world may be placed in a group according to its structure.

The pupils should further understand that only through careful observation and study of plants and animals have scientists been able to divide these living things into groups. They should realize that scientists do not generalize without sufficient evidence. That is, they study thoroughly a number of individuals of a new plant or animal before they decide in which group the new specimen belongs.

Science background

No child will be completely without science background when he begins the study of this unit. Even if he has had no previous encounter with formal science courses, his own experiences at the observational level will provide much material that the teacher can draw on.

If the child has had the previous experience of using the Primary Science books of the *Basic Studies in Science* program that precede *Discovering Our World*, a number of the units in those books will be valuable background for the study of this unit. He will have had some experience in observing and making generalizations. For example:

Look and Learn: Unit 1, Animals; Unit 4, Outdoors

All Around Us: Unit 1, Animals; Unit 4, Plants

How Do We Know?: Unit 1, Animals; Unit 3, Plants

General concepts

These are the larger concepts to be taught in Unit 1. The subsidiary concepts necessary for the development of these larger concepts are listed at the beginning of the problem in which they are developed.

This list will be of value to the teacher in two ways: (1) It will give her a clear picture of the learning objectives of the unit and will thus help her keep her teaching focused on these objectives. (2) It will aid her in preparing test materials to check her pupils' comprehension of the important ideas developed in the text.

1. Things that are alike in certain ways are put into a group.
2. All the things in the world may be divided into two groups: living things and non-living things.
3. All living things are either animals or plants.
4. The parts of anything and the way the parts are put together make up the structure of the thing.
5. Both animals and plants are divided into groups according to certain similarities in their structure.

Introducing the unit (Pages 9-10)

As the title *Discovering Our World* suggests, the major emphasis is on the activity of finding out the answers to problems in science. Various means are suggested including reading the text and references, asking persons who have the desired knowledge, observing carefully and accurately, and experimenting. In Unit 1, the approach is through careful observation, asking, and reading. Below are given some suggestions as to the materials needed for the unit as a whole. Additional suggestions will be found in each problem as needed. For helpful books that may be used as part of the reading approach, consult the Bibliography on page 85.

It is not necessary to purchase anything for the study of this unit. The materials needed to develop the concepts and enrich the teaching of Unit 1 should be collected by the pupils themselves in so far as possible. The collected materials should include examples of both living and non-living things. The animals should be of as many different kinds as possible—frogs, toads, turtles, insects, a rabbit, cat or dog, etc. Probably most of these things will be brought in as a result of the teacher's request in the first lesson. If the schoolroom has an aquarium or a terrarium, much good use can be made of it. The kinds of wild things brought in will, of course, vary with the locality.

In addition to the pictures in the text, many fine pictures of plants and animals can be found in magazines and other sources. These should be collected and kept on file from year to year.

A magnifying glass is a very valuable aid. Children can often bring magnifying glasses.

Proper care of the plants and animals brought into the classroom is, of course, essential. Suggestions for caring for animals and plants will be found on pages 90-93 of the *Guidebook*.

Procedure

A good way to begin the study of this unit is to have the children read and discuss pages 9-10. This will help the teacher stimulate interest on the part of each child in bringing something to class. Anything that a child brings can be used in the study of this unit. Of course, some provision must be made for exhibiting these materials. A shelf, such as the one in the picture on page 11, can be built along one side of the schoolroom. Tables will also serve this purpose.

What are the two big groups of things? (Pages 10-11)

Concepts

1. All the things in the world can be put into two groups: living things and non-living things.
2. A living thing is something that is alive now or once was alive.
3. A non-living thing never was alive.

Procedure

The teacher should take the time to show interest in all the things brought to school. This will encourage the children to continue to bring in material. The pictures in the book showing the various plant and animal groups should be carefully studied. However, the most effective materials are the actual specimens brought by children. Discuss various ways of arranging this collection and then read page 10. Have the children try to pick out the things that are alike before reading page 11 to find out how another class solved this problem.

Questions (Page 11)

1. Observe. Read.
2. They tell what things look like, what they feel like, what they sound like, and what they smell like.
3. So that they could learn to put things into groups.
4. It is easier to find things, to compare things, and to keep track of things if they are put into groups.
5. Answers individual.

How are all living things alike? (Pages 12-14)

Concept

All living things are alike in these ways:

a) They can move.
b) They can breathe.
c) They need food.
d) They can grow.
e) They can have young like themselves.

Information for the teacher

PICTURES. PAGES 12-13. These are the flowers of the magnolia, a tree that grows abundantly throughout the southern states. In regions where the magnolia is found, pupils may be able to watch these blossoms open if they wish to take time to observe them on warm, quiet days.

PAGE 14. These are young king snakes. Not all snakes hatch from eggs. Some are born alive. The king snake is helpful to us because it feeds on mice, rats, and other rodents. King snakes are found in eastern North America from southern New Jersey to northern Florida.

Procedure

Have the children carefully observe the things in their collection and pick out the ones that they know are living things. Animals will probably be named first, since they are more obviously living things than are plants. Let the class give ways in which the living things named are alike. Then the children can check their findings by reading pages 12-14.

Before going on to the next problem, be sure that the class understands that all living things —plants as well as animals—are alike in certain ways. It is especially important to do this if the children failed to pick out plants when they named the living things in their collection.

Questions (Page 14)

1. Can move; can breathe; need food; can grow; can have young like themselves.
2. Living things: fur, hair, bone.
3. Answers individual.
4. Yes. They can have young like themselves.

How are all non-living things alike? (Pages 15-16)

Concept

All non-living things are alike in these ways:

a) They cannot move.
b) They cannot breathe.
c) They do not need food.
d) They cannot grow.
e) They cannot have young like themselves.

Procedure

As in the preceding problem, have the children carefully observe the things in their collection. Ask them to pick out the non-living things. Let them give ways in which the non-living things are alike. They should discover that non-living things can carry on none of the activities of living things. This fact can be effectively brought out by having the class compare a non-living thing with a living thing of the same name, such as a toy soldier and a real soldier, artificial fruit and live fruit, or a cloth dog and a live dog. Then the class can check its findings by reading pages 15-16.

The activity of sorting, arranging, and labeling the living things and the non-living things should not be hurried. Each child should be able to tell why he is putting a thing in one group or the other. He must know that a living thing is something that is alive now or that was alive at one time. For this reason, a dead animal, such as a dead butterfly, is placed with the living things. Each child should also be able to give five reasons why he knows that a thing is a living thing; that is, it can move, can breathe, needs food, can grow, and can have young like itself. On the other hand, the child must understand that a non-living thing never was alive. He should be able to give five reasons why a thing is a non-living thing; that is, it cannot carry on any of the activities of a living thing.

If the distinction between living things and non-living things is clearly understood, the children should have no difficulty in sorting out the things in their collection. Parts of an animal or plant, such as a bone, a feather, a shell, a leaf, a seed, or a twig, should be put with the group of living things. However, articles made wholly or partly from living things should not be put in the group of living things. A wooden chair or hammer handle is a non-living thing. So is a cotton handkerchief, a woolen coat, or a silk scarf. All of them were made from parts of living things; but none of them, as such, can or ever could carry on the activities of a living thing. The wood in a chair came from a tree, which was at one time a living thing. But the chair itself cannot move, cannot breathe, does not need food, cannot grow, and cannot have young like itself. For the same reason, products of animal or plant origin, such as milk, paper, coal, and petroleum, should be put in the group of non-living things.

Questions (Page 16)

1. Cannot breathe; cannot move; do not need food; cannot grow; cannot have young like themselves.

2. Not alive now or at any time.

3. *Living things:* apple, red-winged blackbird, grasshopper, boy. *Non-living things:* nail, flatiron, ball, bicycle, bottle, spoon, penny.

4-5. Pupils should show that they understand how living and non-living things differ.

6. Answers individual.

What are the two biggest groups of living things? (Pages 17-18)

Concept

All living things are either animals or plants.

Information for the teacher

PICTURES. PAGE 17. Rats have different parts and shape from geranium plants; can move around; take food and water through their mouths. Geraniums take water through their roots, and you cannot see that they get or use food. You can see the rats breathe, but you cannot see that plants take in and use air.

PAGE 18. *Plant group:* tree, grass, flowers, water lilies, cattail, log. *Animal group:* dog, fish, dragonfly, turtle, children.

TEXT. The following brief classification of animals and plants will help give the teacher an overview of the animal and plant kingdoms. Within each large subdivision, the groups are listed in the descending order of complexity.

Brief Classification of Living Things

(Starred groups mentioned in Unit 1)

I. ANIMALS

A. Animals with backbones (Vertebrates)
   1. Mammals*
   2. Birds*
   3. Reptiles*—snakes, turtles, lizards, alligators
   4. Amphibians*—toads, frogs, salamanders
   5. Fish*

B. Animals without backbones (Invertebrates)
   1. Insects*
   2. Arachnids*—spiders, daddy-longlegs, scorpions, etc.
   3. Myriapods*—centipedes, etc.
   4. Crustaceans*—crabs, crayfish, lobsters
   5. Mollusks*—snails, clams, oysters, etc.
   6. Worms*—earthworms, etc.
   7. Echinoderms*—starfish, sea urchins, sand dollars, etc.
   8. Coelenterates—jellyfishes
   9. Sponges
   10. Protozoa—amoeba, paramecium, malaria parasite, etc.

II. PLANTS

A. Plants with seeds
   1. Flowers; seeds in fruits*
   2. No flowers; seeds in cones*

B. Plants without seeds
   1. Ferns*
   2. Mosses*
   3. Algae*—seaweeds, pond scum, etc.
   4. Fungi*—mushrooms, puffballs, molds, bacteria, etc.

Procedure

Have the children look at all the living things in their collection to see whether they can find the two groups into which living things are divided. After their discussion, have them read pages 17-18. The children should then have no difficulty in separating the plants from the animals, although they may not be able to give many ways in which the two groups differ. This unit stresses the similarities of the two groups. The teacher should bring out the fact that although plants move as they grow, their roots keep them from moving from one place to another as animals do. She might also mention that many animals can see, hear, taste, smell, and feel but that plants cannot do any of these things.

Questions (Page 18)

1. The children's answers should contain the ideas brought out in answer to the question over the picture on page 17.

2-3. The lists of plants and animals should show that the children understand how plants and animals differ.

How can we tell what group an animal belongs in? (Pages 19-20)

Concepts

1. *Structure* means the parts of a thing and how the parts are put together.
2. Animals may be divided into different groups according to their structure.

Information for the teacher

Pictures. Page 19. No. (See page 20.)

Page 20. From the picture and from experience with squirrels and frogs, the children may make the following comparisons:

Squirrel has fur.	Frog has smooth skin.
Squirrel has tail.	Frog has no tail.
Squirrel has ears.	Frog has no visible ears.
Squirrel has feet that can pick things up.	Frog has feet for swimming.
Squirrel has teeth.	Frog has no teeth.

Procedure

In this problem, structure is introduced as the scientific basis for classifying animals. The concept of structure underlies the remaining problems of this unit. In the final problem, the concept is extended to include plants. Accordingly, the class must have a clear understanding of structure before leaving this problem.

Develop the meaning of the word *structure* by having the class read and discuss pages 19-20. The questions on page 20 will be useful in directing class discussion. Be sure that the children understand that structure means both the parts of a thing and the way in which these parts are put together.

Questions (Page 20)

1. *Alike:* have four legs, hair, tails, ears, teeth.

Different:

Horse has hoofs.	Dog has paws.
Horse has mane.	Dog does not.
Horse has teeth for eating grass.	Dog has teeth for eating meat.
Horses are bigger.	

2. *Fish:* fins, scales, flat body, no legs. *Bird:* two legs, two wings, feathers, bill.
3. Child's own structure: two arms, two legs, hands, feet, head with hair, eyes, ears, nose, mouth, and teeth.
4. Structure tells scientist what parts animal has and how the parts are put together. When he knows this, he can put animals that are alike in structure in the same group.
5. Answers individual.

What is a mammal? (Pages 21-23)

Concepts

1. All mammals are alike in these ways:
   a) Mammals have fur or hair.
   b) The babies are fed with milk from their mothers' bodies.
   c) Mammals are warm-blooded.
   d) Mammals take air into their bodies with lungs.

2. The temperature of the blood of some animals stays about the same all the time. These animals are *warm-blooded.*

Information for the teacher

Pictures. Page 22. *Armadillo.* Found in Texas. The skin of the armadillo has developed into a hard covering of bony plates on which there is a scant covering of hair, difficult to see in a picture.

Red fox. Found in most of the United States and Canada in forested and rolling country where the vegetation gives protection.

Chipmunk. Found throughout the United States.

Woodchuck. Found in most of the United States and southern Canada. In some parts of the country, this animal is known as the marmot. Also called a ground hog.

Skunk. Found throughout most of the United States and Canada except in deep forests and deserts. Skunks eat mice and other harmful animals and should be protected.

Meadow mouse. Found in fields and meadows over most of North America. Mostly nocturnal. Extremely prolific. The meadow mouse consumes much food such as hay, grains, etc.

Page 23. *Kangaroo.* Found in Australia.

Llama. Found at high altitudes in western and southern South America. Used as beast of burden in Peru and Bolivia.

Tiger. Found in India and other parts of southeastern Asia. A tiger usually does not prey on people unless it is old or otherwise unfitted for hunting its natural prey.

Bear. This is a grizzly bear. Now found only in the least accessible parts of the Rocky Mountains.

Seal. A marine mammal of high latitudes. Feeds mostly on fish.

Pointer dog. A breed of dogs trained to scent and point out game.

Procedure

The teacher should select two or three mammals from the group of animals on the shelf and ask the class to find ways in which they are alike. Suggest that the class find out what all of these animals are covered with, how they feed their babies, etc. After the children have made their list of ways all mammals are alike, have them check the list by reading pages 21-23. Stress the meaning of *warm-blooded.* To make sure that the class understands what a mammal is, show them many pictures of animals from which they are to select the mammals. After some of the children have made the label *Mammals,* they should bring as many mammals as they can to place beside it. Many of these, such as a cat, dog, or lamb, should be taken home that day. Others, such as a rabbit, white rats, or a guinea pig, may be caged and cared for in the schoolroom. (See pages 90-93 of this *Guidebook.*)

Questions (Page 23)

1. Mammals: dog, horse, cow, beaver, lion. They have fur. Babies are fed milk from the mother's body. (Children may not know the other criteria about these animals.)

2. Pictures of mammals will be found on pages 11, 14, 16, 17, 18, 19, 20, 21, 22, 23, 26, 38, 44.

3. Some animals which are not mammals, such as frogs and toads, also have four feet.

4. *Like:* Can grow, move, breathe, eat, and have young like itself. *Different:* Has fur or hair and feeds its young milk from its own body.

5. Mammals that live in water are whales, porpoises, and sea cows (manatees). Seals, sea lions, walruses, otters, etc., spend part of their lives in water and part on land.

How are birds different from other animals? (Pages 24-25)

Concept

All birds are alike in these ways:

a) Birds are covered with feathers.
b) Birds have two wings and two legs.
c) Birds have bills.
d) Birds are warm-blooded.
e) Birds breathe with lungs.

Information for the teacher

Pictures. Ranges of the birds shown on pages 24-25:

Magpie. Treeless or more sparsely wooded districts of western America, except coast and interior of California; north to northwest Alaska; south to Arizona, New Mexico, and west Texas.

Parrot. Mexican double yellowhead parrot. A pet in this country.

Hummingbird. (ruby-throated). Eastern North America to about middle portion of Great Plains (along streams); south to middle Florida and along the Gulf Coast to west central Texas; north through eastern Kansas to North Dakota.

Baltimore oriole. Eastern temperate North America and west to central Montana and eastern Colorado; south to north Georgia, central Louisiana, and south Texas.

Bobwhite. In the North, this bird is usually called a quail. In the South, it is called a partridge. Found in eastern North America from eastern Colorado, South Dakota, southern Minnesota, southern Ontario to southwestern Maine; south to eastern and northern Texas, the Gulf Coast, and northern Florida.

Puffin. Coasts and islands of North Atlantic. Breeds in North America, south to Bay of Fundy and Maine. Winters south to Massachusetts, rarely to Long Island and Delaware Bay.

Wild turkey. Eastern United States from Nebraska, Kansas, western Oklahoma, and eastern Texas east to central Pennsylvania and south to the Gulf Coast. Formerly north to South Dakota, southern Ontario, and southern Maine.

Ostrich. Deserts of Africa and Arabia.

Mallard duck. Most of the northern hemisphere. It is abundant wherever it has not been destroyed or reduced in numbers by man.

Horned owl. Western hemisphere from northern limit of trees in the arctic zone south to the Straits of Magellan.

Pelican. American white pelican.

Lyrebird. Thick forests in Australia.

Flamingo. Atlantic coast of subtropical North and South America from the Bahamas, Florida keys, and Yucatan to Brazil and the Galapagos Islands.

Procedure

The class should look at both a canary and a chicken if possible. They may see sparrows, robins, or other birds near school. They should also look at the pictures of birds on pages 24-25. The teacher can help their observations by asking again, "What are birds covered with?"

After listing in their own words the ways birds are alike, the children should read pages 24-25 to check their list. If they do not have any live birds in their collection to be placed by the label *Birds*, some stuffed birds may be brought to class.

Questions (Page 25)

1. *Like:* Have lungs and are warm-blooded. *Different:* Have feathers, two wings, two legs, and bills.

2. Yes. Has feathers and a bill, two wings and two legs.

3. No. Bee does not have feathers. Has more than two legs. Does not have a mouth with a bill. Has more than two wings.

How are all reptiles alike? (Pages 26-29)

Concepts

1. All reptiles are alike in these ways:
    a) Reptiles are covered with scales or a shell made of scales.
    b) Reptiles have either very short legs or no legs at all.
    c) Reptiles are cold-blooded.
    d) Reptiles breathe with lungs.

2. *Cold-blooded* means that the animal's blood changes temperature when the temperature around the animal changes.

3. Snakes and other wild animals must be handled carefully.

Information for the teacher

Pictures. Page 26. The Indigo snake is also known as the Gopher snake, since it often uses the burrows of the Gopher tortoise. The Indigo snake is found in South Carolina, Georgia, Florida, and westward through the other Gulf states to eastern Texas. It is often encouraged to stay around homes and barns because it eats rats. Its docile disposition makes it a good snake for study or for a pet.

Page 27. This snake is a water moccasin or cottonmouth moccasin. It is found in swamplands in the southern Mississippi River region and eastward.

Page 28. A spotted turtle. This turtle is very abundant in eastern North America.

Page 29. This is a group of American crocodiles on the banks of a lake in Honduras, Central America. Crocodiles are found in the rivers and swamps in tropical countries. This species is found in Central America, the West Indies, and southern Florida. However, they are rare in Florida and should not be confused with the alligators found throughout the state and at alligator farms. The bird on the dead limb is called a snake bird.

Text. There are four kinds of poisonous snakes in the United States:

Rattlesnake. Various species found all over the United States, but most prevalent in arid or semi-arid regions covered with brush.

Copperhead. Eastern United States and parts of the central region. The top of the head is copper-colored.

Water moccasin or *cottonmouth moccasin.* It gets its name from its whitish mouth, which it opens wide when it is startled or when about to strike. It is closely related to the copperhead but lives in or near water, while the copperhead prefers rocky hillsides and similar places.

Coral snake. A small, slender snake, beautifully colored with coral, black, and yellow rings. It is found from North Carolina to the Gulf of Mexico westward through Texas. This snake is exceedingly poisonous but fortunately not encountered so frequently as the other three. It likes to burrow under bushes and stumps and in the ground.

Children who live in areas where these poisonous snakes are common should learn to recognize them. However, most snakes are helpers and should be conserved. They eat mice, rats, and other rodents as well as harmful insects.

Procedure

If possible, have a small snake or a snakeskin, a turtle, and a baby alligator in the classroom. Have the children find pictures of reptiles. Then let the children examine a piece of snakeskin to see the scales. Also have them look at a turtle's shell made of scales, and notice the scales on the turtle's neck and legs. Then the class should read pages 26-29. Stress the meaning of *cold-blooded.* Have a label *Reptiles* made and place all the reptiles beside it.

Questions (Page 29)

1. Have scales; are cold-blooded.
2. Breathe with lungs.
3. (a), (c).
4. When an animal is warm-blooded, it has about the same temperature all the time. When it is cold-blooded, its temperature changes with the temperature around it.
5. (*a*) Do not disturb a snake while it is eating. (*b*) Pick up a snake by holding it just back of the head. (*c*) Do not get near a snake unless you are sure that it is not poisonous.

How are all fish alike? (Pages 30-31)

Concept

All fish are alike in these ways:

a) Fish are usually covered with scales.
b) Fish have fins.
c) Fish are cold-blooded.
d) Fish breathe with gills.

Information for the teacher

Pictures. Page 30. *Large-mouthed bass.* Found in both cool and warm rivers, streams, and lakes throughout the eastern United States.

Catfish. Also called a bullhead. Found in ponds and sluggish streams all over the United States. It is one of the fish without scales.

Sea robin. Found in the Atlantic Ocean from Cape Cod to Virginia. In this fish, three or four rays of the forefins are developed separately to look like claws. With these, it feels along the bottom and pulls itself forward or backward so that it looks as if it is walking.

Swordfish. The adult swordfish has no scales. It may grow to great size, as much as 16 feet long and weighing 300 lbs. It is found in the Atlantic from Newfoundland to Florida, and in the Pacific off the coast of southern California.

Blue-headed wrasse. A surface fish abundant in the tropical zone, where it is found among the coral reefs. It may also extend into the temperate zone along rocky parts of the coast that are overgrown with seaweed.

Electric skate. A tropical member of the ray family. Rays and skates are flat and live on the bottom of the ocean. The electric skate is so called because it has certain muscles capable of storing electrical energy and discharging it when attacked by an enemy.

Moorish idol. Tropical fish of the middle and eastern Pacific.

Tarpon. Found in southern waters around Florida. Also called Silver King because of its large size and silvery appearance.

Sea horse. Although it does not look much like a fish, it has fish parts. It swims upright, using a fin on its back. It is covered with bony plates and hangs onto seaweed with its tail. It is the only fish that can use its tail this way. It is a very small animal, usually about five inches long. Found in salt water from North Carolina to Brazil, north to southern California on the Pacific Coast.

Procedure

After the children have observed a live fish in an aquarium to find the structure of fish, have them read pages 30-31. Be sure that the children understand the difference between fish and reptiles. Review the meaning of *cold-blooded.* Bring out the fact that a fish's blood is colder when the fish swims in cold water than it is when the fish is in warmer water.

Questions (Page 31)

1. Has fins and breathes with gills.
2. Have skin usually covered with scales; are cold-blooded.
3. Fish have fins and breathe with gills.

What are amphibians? (Pages 31-32)

Concepts

1. Amphibians are alike in these ways:
   a) Amphibians breathe with gills when young; with lungs when grown.
   b) Amphibians are covered with skin.
   c) Amphibians are cold-blooded.
2. By careful observation and reading, it is usually possible to find out what an unfamiliar animal is.

Information for the teacher

Pictures. Page 32. The toad is the small Fowler's toad, commonly found throughout the United States. The salamander is the slimy salamander, one of the forest-dwelling salamanders found in the eastern and central states.

Procedure

Have the children read pages 31-32, which tell how the class was able to identify an unfamiliar animal. This shows the significance of animal groups and how identifying animals is made easier by dividing them into groups. Develop the meaning of the word *amphibian.* Most of the children have heard about amphibian airplanes that can take off or land on either water or land. By observing frogs, toads, or salamanders and reading pages 31-32, the children can find out what an amphibian is. They should then place the amphibians in their collection beside the label *Amphibians.*

Questions (Page 32)

1. Observing and reading.
2. Cold-blooded.

3. *Different from fish:* covered with skin; have lungs when full-grown. *Different from reptiles:* covered with skin; have gills when young.

How are all insects alike? (Pages 33-36)

Concepts

1. Insects have a hard covering on the outside of their bodies instead of a skeleton of bones.
2. All insects are alike in these ways:
   a) Insects have six legs.
   b) Insects have two feelers.
   c) Insects have bodies that are divided into three parts.
   d) Insects have a hard covering on the outside of their bodies.
   e) Insects breathe through breathing holes along the sides of their bodies.

Information for the teacher

PICTURES. PAGE 33. This is a diagram representing the parts of an ideal insect. Insects that will be brought in will doubtless show variations from this. In many insects, the three parts of the body may be fused so that they will not be so clearly discernible. Some insects have only two wings. A few, such as aphids or plant lice, have none. In others, such as beetles, the hard outer wings meet in the middle of the back and form a cover for a second pair of wings underneath.

PAGE 34. Children probably know some of these insects. The less familiar ones are:

Water strider. Commonly found on the surface of quiet ponds or slow streams. They are able to glide over the surface without breaking it because their hairy legs do not get wet.

Damsel fly. Common in marshes or near shallow pools where there is some vegetation. They belong to the group of insects known as darning needles.

Long-horn beetle. One of a group having very long antennae. This one is found in the eastern United States.

Ground beetle. Found under cover in gardens, fields, and open woods. They are helpful insects because they eat the caterpillars of several harmful moths.

Electric tumblebug. One of a widely distributed group of beetles that characteristically roll their food up into balls and roll it ahead of them to their nests.

PAGE 35. In this picture are three insects and three animals belonging to groups often confused with insects.

Insects. Luna moth. May be found from Canada to Florida and west to Texas. The caterpillar feeds on hickory, walnut, sweet gum, and several other forest trees. It makes a thin cocoon of silk and leaves on the ground.

Swallowtail butterfly. This is the zebra swallowtail, which is common in the eastern United States. The markings may vary somewhat in different specimens as this butterfly has several different forms. The caterpillar feeds on the leaves of the pawpaw tree.

Praying mantis. Various species found throughout the United States. The front two legs are used for capturing other insects. It holds these legs up as if it were praying while waiting for some insect to come along.

Other groups. The *spider* and the *daddy-longlegs* belong to the group known as Arachnids. Arachnids have four pairs of legs, no wings, and no antennae. Scorpions and tarantulas are also Arachnids.

House centipede. Belongs to another group, the Myriapods, which means many-legged animals. The house centipede may be found in damp basements.

TEXT. For information on how to keep insects alive in the classroom, see page 90. A bulletin that may also be helpful is: *How to Keep Insects and Study Them*, published as School Nature League Bulletin, Series No. 14, No. 10, June 1944. (See Bibliography, page 89 of the *Guidebook.*)

Procedure

Use the procedure on page 33 of the text. So that each child can have an insect to observe, have on hand many live and dead insects, such as grasshoppers, crickets, ants, bees, wasps, and flies. As a child answers the questions for the insect he has observed, write his answers on the blackboard. The class should then notice the sameness of these answers to questions asked about different insects.

The first three questions can probably be answered with little help from the teacher. Have the class read page 33 and the left-hand column of page 34 to check their answers. The children may be somewhat uncertain about the answer to the fourth question. Have them read the right-hand column of page 34 to clear up any doubts about the coverings of insects.

The fifth question may require additional help from the teacher, since the breathing holes are not easily seen on all insects. It is therefore a good plan to have the class see these holes, which look like black dots, along the sides of a grasshopper. A magnifying glass will aid these observations. Then have the class read the first two paragraphs on page 35 for further understanding of what they have seen.

Now the children are ready to check their list of the ways in which all insects are alike with the list on page 35. The class may reread pages 33-36, comparing their own remarks and observations with those of the boys and girls in the book. At this point, stress the names for the parts of the body given on pages 33-34. Have the children find these parts on the insects that they examined.

Be sure that the class understands why animals such as the spider, daddy-longlegs, and centipede are not insects. If possible, have specimens of these animals for the children to observe so that they can see that all of these animals have more than six legs. The class can then place all the insects in their collection beside the label *Insects*.

Questions (Page 36)

1. Have six legs, two feelers; body divided into three parts; hard covering on the outside of their bodies; breathe with holes along sides of their bodies.
2. Through holes along the sides of their bodies.
3. All.
4. A bee is an insect.
5. It has eight legs and two parts to its body.
6. List will probably include flies, bees, butterflies, grasshoppers, ants, mosquitoes, crickets, wasps, moths, beetles, etc.

Are there other groups of animals? (Pages 36-37)

Concepts

1. There are other groups of animals besides those mentioned in the text.
2. These groups of animals have no skeleton of bones inside their bodies.

Information for the teacher

There are many common animals without backbones besides insects, which the children may bring in for their collection. This will be especially true in the regions along the coasts, where starfish, sea urchins, and other invertebrates are found on the beach and in the tide pools.

Animals such as snails, clams, and other animals that live in shells belong to the group called Mollusks. These have soft bodies protected by a hard shell.

Starfish and sea urchins belong to the Echinoderms, or spiny-skinned animals. The little round white shell in the picture of the sea urchin on page 37 is what is left when the animal dies and the spines have broken off. Such shells are often found on the beach or in tide pools. Living specimens are usually found in pools. Children in Florida and California may bring in the shell of another of this group, the sand dollar. It is a round, flat animal covered with short spines. The flat shell without the spines is often found on the beach.

Crayfish, crabs, lobsters, and shrimps belong to the group known as Crustaceans, or shell animals. They have a hard outer covering as the insects do. This is a different kind of shell from the one that clams, oysters, etc., have.

These animals belong to the other groups of invertebrates and are often a great source of interest to children. A good pond book and a good seashore book are valuable to have at hand when studying this lesson. See the Bibliography on page 85 of the *Guidebook*.

In preparation for the next lesson, on plants, ask the children to look for some plants that have flowers or seeds and to bring them for the next class meeting.

Procedure

Have the class read pages 36 and 37 about other groups of animals. As they place animals from their collection beside the label *Other Animal Groups*, ask why the animal is not a mammal, a bird, a fish, a reptile, an amphibian, or an insect. This offers an opportunity for a good review of those groups.

What are the two big groups of plants? (Pages 38-43)

Concepts

1. Plants may be divided into different groups according to their structure.
2. Many plants have roots, stems, leaves, flowers, and seeds.
3. Plants are divided into two big groups:
    a) Plants that have seeds.
    b) Plants that do not have seeds.
4. Some plants that have seeds grow their seeds in flowers.
5. Some plants that have seeds grow their seeds in cones.
6. Plants that do not make seeds have spores.

Information for the teacher

PICTURES. PAGE 38. The children in this picture of an elementary science class are studying the different kinds of evergreens as an autumn plant activity. This method of getting practice in observing characteristics and describing them can be adapted to other kinds of trees and other plants. The evergreens are an excellent source of plant material if this part of the unit is studied after frost has killed most of the other plants.

PAGES 40-41. Many tree flowers are so inconspicuous that they are hardly noticed. The pussy willow and the black walnut belong to the group of plants having their flowers in catkins. The individual flowers are very tiny and are grouped together along a spike called a catkin that sticks up as in the pussy willow or that hangs down as in the black walnut or in the cottonwood.

Maple flowers are tiny, too. Those of the sugar maple, shown on page 40, have long stalks and hang down. Other maples have their flowers on short stalks so that you must look closely at the branches to see them.

The fern is the marginal fern, so called because the spore cases are found along the margins of the leaves. It grows in rich, rocky woodlands.

Puffballs look white or delicate pink when they are fresh. They turn brown like the ones in the picture when they are ready to shed spores. Puffballs grow in various places: on old logs, at the bases of tree trunks, and some in open fields where they may grow very large.

PAGE 42. This mushroom is the dangerous "fly" agaric or "fly" Amanita, one of the most poisonous mushrooms. It is found very widely in this country in late summer and early autumn in woods and along roads near trees. It should not be touched.

TEXT. PAGE 40. If the children look at a sunflower or similar plant, they will probably remark that the seeds are not in a pod as they are in the bean. Plants in the group to which sunflowers, dandelions, and similar flowers belong, do not have pods or other types of seed containers holding many seeds. Each "seed" is really a pod, or fruit, containing one seed. The seed is so closely joined to its container or pod that the two cannot readily be separated.

The botanical meaning of *fruit* is not used here as it is not necessary to the development of the concepts in this unit. In the event that it has been taught earlier (as in *How Do We*

Know?) make sure that it is clear that *fruit* simply means the part that develops from part of the flower and holds the seeds.

The children may bring in various fruits since this unit is taught in the fall. The milkweed pod is a fruit that may be brought in. Nuts are really fruits, too. The seed is the part that we eat. However, it is not necessary to make this distinction at this level unless the question is brought up by the pupils.

PAGE 41. Grass flowers are hard to see without a magnifying glass. If a file of the *National Geographic Magazine* is available, obtain the number for June 1921. The article "Familiar Grasses and Their Flowers" has a series of excellent pictures in color of the flowers of some of the most common grasses.

Leaves of ferns are more correctly called *fronds*. Fronds that have spores may easily be obtained from a greenhouse. Spores are not at all like seeds in structure, but they act as seeds in that new plants grow from them.

Puffballs may not be obtainable, but the idea of spores can be developed by using the fern as an example of a spore-bearing plant.

PAGE 42. The term *toadstool* is popularly applied to poisonous mushrooms such as the one on this page. To a scientist, there is no such classification as toadstool. Mushroom is a broad term that covers all the fleshy fungi, whether edible or not. This includes mushrooms of the umbrella type, the puffballs, and other less common forms.

Children at the shore may bring in seaweeds. The seaweeds belong to the group of plants known as Algae. The seaweeds usually collected belong to the groups of brown or red algae. Some of the seashore books in the Bibliography will give helpful information about some of the algae commonly collected.

Salt-water algae are difficult to keep alive unless a supply of sea water is easily obtainable. They make a fine collection, however, when mounted on cards or large sheets of paper and dried flat. (See *Things to Do*, page 45, No. 7.)

The characteristic that separates the seed-bearing plants into two groups is the way in which the seeds are borne. The ones with flowers have their seeds in closed containers or fruits. The ones with cones have the seeds in open containers, that is, at the bases of the scales of the cones. When the cones ripen, the scales spread apart and allow the seeds to fall.

Procedure

Have the class read pages 38-39. Stress the fact that plants have structure, just as animals do. Use the garden plants that the children have brought to school and follow the procedure used by the teacher in the text in studying them. Have the children observe the plants carefully to see that the seeds are formed in the flowers.

Now have the children read page 40 and the first two paragraphs on page 41. Ask the children to find different tree seeds, such as those of the oak or maple. (If the children should bring in the seeds that grow in cones, refer them to the last paragraph on page 42 and page 43 for an explanation.)

Ask the class whether they have ever seen flowers or seeds on a fern. Follow the procedure of the teacher in the text in her method of presenting plants without seeds and in stressing the important points. Have the children read the rest of page 41 and page 42 up to the last paragraph to check their findings.

Then have the children read the last paragraph on page 42 and page 43 if they have not already done this. The class should now sort the plants in their collection into two groups: (1) those that have flowers and seeds and (2) those that have no flowers and no seeds. Each group should be put with its label.

Ask the children to compare their collection with the one shown in the pictures on pages 44-45. Have them name the things in each group shown in the pictures and tell why each one belongs in that group. For example, the wooden basket at the far right on page 45 belongs with the non-living things, because a basket cannot carry on any of the activities of a living thing even though it is made of wood that was once part of a living thing.

Questions (Page 43)

1. Has red flowers; has roots, stems, leaves; has a short, thick root; has big, thick leaves; has seeds and flowers; has spores.

2. In part of the flower.

3. *With seeds:* snapdragon, bean, sunflower, sweet pea, petunia, pea, bean, aster, pansy, pussy willow, maple, beech, hickory, walnut, apple, horse chestnut, locust, grass, corn, wheat, pine, spruce, fir, hemlock. *Without seeds:* fern, puffball, mushroom, moss, seaweed.

Questions to answer (Page 44)

1. The answer to this would of course depend on the kinds of buttons in the collection. But they could be divided on the basis of these differences: size (large or small); material (wooden or pearl); shape; color; number of holes or loops; etc.

2. Look at the things carefully. Find out how they are alike or different in structure and put the things that are alike in the same group.

3. Have six legs and a body divided into three parts.

4. No. You would need to examine a great many insects before you could make a statement about all insects.

5. Look at its structure carefully and decide what big group of animals it belongs in. Look in a book that deals with this group. Compare its structure with that of the animals in the book. Go to a museum or ask someone else who knows.

6.

Living Things		*Non-living Things*
Mouse	Peach tree	Nail
Cricket	Turkey	Rock
Toad	Sheep	Bottle
Geranium	Duck	Pen point
Mushroom	Grasshopper	Paper clip
Moss	Salmon	
Snake	Alligator	
Sunfish	Frog	
Penguin	Pine tree	
Ant	Dandelion	
Fox	Orange	
	Oak tree	

Mammal	*Bird*	*Reptile*	*Fish*	*Amphibian*
Mouse	Penguin	Snake	Sunfish	Toad
Fox	Turkey	Alligator	Salmon	Frog
Sheep	Duck			

Insect	*Plants with Seeds*	*Plants without Seeds*
Cricket	Geranium	Mushroom
Ant	Peach tree	Moss
Grasshopper	Pine tree	
	Dandelion	
	Orange	
	Oak tree	

Things to do (Page 45)

1. If there is a zoo in your town or city, a visit would be an interesting and valuable experience.

2. Pictures may be found in newspapers and magazines.

3. Individual activity.

4. This may be used as an individual or class activity.

5. Use as a class field trip.

6. A good review activity.

7. Seaweeds may be mounted by placing them in a shallow pan of water and floating the specimens onto a sheet of heavy mounting paper in as nearly normal position as possible. (The finely divided or feathery ones can be straightened out by shooting water onto them with a medicine dropper.) Carefully drain off the excess water and cover the specimen with a piece of cheesecloth. Place the sheet between driers, such as blotting paper. Then apply some pressure to flatten the sheet and help make the specimen stick to the sheet. After they are dry, remove the cheesecloth. The specimen will remain fixed to the sheet of paper.

8. A bat is a mammal.

9. Snakes destroy harmful pests such as insects, mice, rats, and other rodents. Several books and magazines are suggested in the Bibliography on page 85.

10. A whale is a mammal.

UNIT 2. *Why Do All Living Things Need Air and Water?*

Purpose and scope

Unit 1 brought out the fact that all living things can breathe. The unit told how each of the major animal groups get air into their bodies. It explained that plants breathe; but because other major concepts were being stressed, it did not explain how plants breathe. In this unit, therefore, some important facts about air are developed so that the child will understand how plants breathe, that plants and animals must have oxygen to stay alive, and that plants use carbon dioxide to make food. In like manner, such pertinent facts about water are introduced as are necessary to an understanding of why animals and plants need water in order to use or make food. After studying this unit, the class will understand why the plants and animals in their classroom must be supplied with plenty of air and water to stay alive.

Science background

All Around Us: Unit 4, Plants

How Do We Know?: Unit 3, Plants

Discovering Our World, Book One: Unit 1, How Are the Things of the World Put in Groups?

General concepts

1. Air is a material.
2. Everything in the world is either a solid, a liquid, or a gas.
3. Air is found in every place that is not filled by something else.
4. Living things must have oxygen to live.
5. Plants use carbon dioxide from the air to make food.
6. Water is found on the surface of the earth, in the ground, and in the air.
7. Water evaporates.
8. Water vapor condenses.
9. Solid materials can be dissolved in liquids.
10. Water is needed to dissolve foods before living things can use them.
11. Water provides the liquid part of the blood that carries food and oxygen throughout the body.

Introducing the unit (Pages 47-48)

Information for the teacher

PICTURES. PAGE 46. Road through forest of saguaros, or tree cacti, in Arizona.

PAGE 47. The names of the desert plants and animals are, from left to right: chuckwalla (herbivorous lizard), prickly-pear cactus, tarantula (spider family), ocotillo cactus, scorpion, barrel cactus, desert antelope (ground squirrel), desert horned toad (insectivorous lizard), kangaroo rat, saguaro cactus (tree cactus), pigmy owl (in tree cactus).

Procedure

To begin this unit, have the pupils recall that to keep their plants and animals alive, the children must provide water and air. Mention that the insects die if shut up in a tight can, and then ask, "But why must plants and animals have air and water?" Then have the children read pages 47-48 and tell about any experiences they may have had with needing air and water themselves or with caring for plants and animals.

What is air? (Pages 48-50)

Concepts

1. Air is a material. Like any other material, it takes up room.
2. Everything in the world is either a solid, a liquid, or a gas.
3. Air is a mixture of gases.
4. Oxygen and carbon dioxide are two important gases in air.

Experiments and observations

Pages 48-49: To find out whether air is a material.

Materials: Deep pan, cork or chip of wood, glass, water, paper bag.

Procedure

A somewhat dramatic approach to the subject of air, such as having the class guess what is in an "empty" box or waste basket that has been wrapped as a gift, will quickly stimulate their interest and curiosity. After they find out that the box or waste basket is filled with air, they naturally want to know what air is. Then have them read the first paragraph on page 48.

The materials for the experiments on pages 48-49 should be on hand. It is a good plan to choose a committee of several boys and girls to be responsible for materials needed to perform the many experiments given in the book. It might be called the "experiment committee" and should be changed in personnel from time to time so that many children can participate in this responsibility. Also encourage children to think up and try other experiments.

Have the children perform the experiment with the glass, cork or chip of wood, and pan of water. A good way to do this is to have one child read a direction and another child carry out the direction. Sufficient time should be given for observation and discussion by the entire class. Then many children should be given the opportunity of trying the experiment to *feel* how the glass should be *pushed* down into the water. Make certain they see that the cork or chip is on the bottom of the pan when the glass is pushed down into the water. Since these objects float, they, of course, show the height of the water in the glass.

The paper bag experiment is an excellent one to show the children that air is a material. It is not enough to read about this experiment. They need to *see* the paper bag swell out as air is blown into it, and they also need to *feel* it. If then the bag is "popped," a loud noise is made by the air suddenly rushing out of the hole.

Have the class read carefully and discuss the remaining paragraphs about air on pages 49-50. It is important that children learn in a general way about solids, liquids, and gases, as they are mentioned in later units. A collection of solids, liquids, and gases with labels by the children will help them in this understanding. For an activity that can also be used to extend this understanding, see *Things to Do*, page 65, No. 2.

Questions (Page 50)

1. Water, air, food.
2. Description of experiments done on pages 48-49.
3. Wood (table or chair). Probably water or ink. Air. No.
4. Oxygen and carbon dioxide.
5. By freezing; by boiling; by melting.
6. A solid keeps its shape and cannot be poured. A liquid can be poured.

Where is air found? (Pages 50-51)

Concepts

1. Air is found in every place that is not filled by some other material.
2. Air is found in soil, in water, and above the surface of the earth.

Experiments and observations

Page 50: To observe that there is air in cloth.

Materials: Piece of cloth, source of strong light (window, electric-light bulb).

Pages 50-51: To see that there is air in water.

Materials: Pan of water, source of heat.

Page 51: To observe that there is air in soil.

Materials: Glass of water, lump of soil.

Procedure

When the question of where air is found is being considered, it is not sufficient to read that air is found in the hundreds of little spaces in cloth, in water, and in soil. These observations and experiments should be made by the children in the simple ways suggested on pages 50-51. They might enjoy a contest to see who could name the most places in the schoolroom where there is air, such as a cupboard, glass of water, vase full of soil, pan, sponge, clock, desk drawers, cloak room, etc.

The class will be interested in discussing animals that live in the water but must come to the surface for air, such as whales, seals, and frogs. It is interesting to watch goldfish breathing. If a goldfish is placed in a small jar of water, and a colored liquid (such as vegetable coloring used to color candy) is dropped by a medicine dropper near the mouth of the fish, the children can see the colored liquid go into its mouth and out over the gills.

How different water insects breathe is always interesting. For example: (1) water beetles hold air under their wings and use this air to breathe when they are under water; (2) one kind of beetle takes a bubble of air under its abdomen down into the water; (3) mosquito wrigglers push their tails above the surface of the water because they breathe air through holes in their tails. (If oil is poured on the water, the wriggler cannot break through the oil to get air; and therefore it dies.)

Questions (Page 51)

1. Above the earth; in soil; in water.
2. Wave a fan or a piece of paper in the air and feel air pushing against paper; heat water and see bubbles coming out; drop soil into water and see bubbles coming out.
3. Yes. You can blow some out of your lungs through your mouth.
4. The air is thinner up on a high mountain.

What part of the air do animals need? (Pages 52-53)

Concepts

1. Animals need the oxygen in the air to stay alive.
2. Animals take oxygen from the air when they breathe.
3. People need oxygen from the air.
    a) Oxygen helps keep the body warm.
    b) Oxygen helps the body move.

Information for the teacher

Picture. Page 52. Formerly, oxygen was given only as a last resort; but now it is frequently given to ease the patient and to help him conserve his strength.

Procedure

Have the class read pages 52-53. Stress the care with which the scientist did the experiment. This should prove an incentive to the pupils to be careful in their experiments. Emphasize that oxygen is needed to help keep the body warm and to help the body move.

Questions (Page 53)

1. Whether animals needed all of the air or only part of it.
2. He put a mouse into an airtight jar. After the mouse stopped moving, he put some oxygen into the jar. The mouse began to move again.
3. That air is a mixture of gases.
4. Fish use up all the oxygen in the water.
5. No.
6. To keep their bodies warm and to help them move.

How do plants get and use air? (Pages 54-55)

Concepts

1. Plants need air.
2. Air gets into plants through tiny openings in their leaves.
3. Plants use oxygen from the air in order to use food.
4. Plants use carbon dioxide from the air to make food.

Information for the teacher

Picture. Page 54. *Left.* The tiny openings are called *stomata* or *stomates* and are shaped differently in different plants. They open when the cells around the opening (having the green coloring matter) become turgid with water. When these cells lose water and become less turgid, the opening is closed.

Experiment

Page 54: To find out how a plant gets air.

Materials: Two small potted plants that are alike, vaseline.

Procedure

If possible, have the pupils look at a leaf with a low-power microscope to see the many tiny openings through which the plant breathes, or takes in air. It must be made very clear that plants breathe. Plants and animals both breathe in air, and they both use the oxygen in the air. But plants also use carbon dioxide in the air to make food. This is treated in more detail in *Discovering Our World, Book Two:* Unit 8, Where Does All the Food of the World Come From?

It is important to have the class carry on the activity of getting two small plants and covering the leaves of one with vaseline to clog up the openings through which it takes in air. By watching this plant die, the pupils can see that plants, like animals, must have air to live.

After the pupils have examined a leaf and done the experiments with the plants, let them read and discuss pages 54-55. They should also look at the pictures as they carry on the discussion.

Questions (Page 55)

1. The two plants were alike except for the vaseline on the leaves of one. In order to show that it was the covering of the holes with vaseline that made the plant die, one plant had to be left without vaseline.
2. Stone, dead tree.
3. To use food. To make food.

Where is water found? (Pages 56-58)

Concepts

1. Water is found on the surface of the earth, in the ground, and in the air.
2. Water evaporates; it can change to a gas (water vapor) and disappear into the air.
3. Water is always evaporating from the earth.
4. Cold air holds less water than warm air.
5. When the air is cooled enough, water vapor condenses. It changes from a gas to a liquid.
6. Rain, hail, sleet, snow, dew, and frost all come from condensed water vapor.

Experiments and observations

Page 57: To show that water evaporates.

Materials: Glass, rubber band or string, water, paper or cardboard for sign.

Pages 57-58: To find out whether water comes out of the air.

Materials: Metal cup, very cold water or cracked ice.

Information for the teacher

Picture. Page 56. An airplane view of the delta of the Mackenzie River in northern Canada.

Text. Page 57. Steam is also the gas, water vapor. It is water vapor that is formed when water is heated to boiling.

Procedure

Have the children point to all the bodies of water they can find on a large map of the world. Also ask them to tell about the ponds, creeks, rivers, lakes, or oceans that they have seen, as well as springs and wells. If the children go outdoors after a heavy rain, they can see that part of the water runs off and part soaks into the ground. Then have the class read page 56 and the first two paragraphs on page 57.

The children should perform the experiments on pages 57-58. There are many other activities they can do that will further demonstrate evaporation, for example: making a mark showing the height of the water in an aquarium and checking daily to see if it remains the same; washing a portion of the blackboard and discussing where the water goes as the blackboard dries; watching water in a bird bath gradually disappear; watching a wet cloth dry; noticing the puddles of water disappear shortly after a rain; etc. As the pupils are discussing these and other experiences, encourage them to use the terms *evaporate* and *water vapor*.

After the children have seen the drops of water on a metal cup filled with ice and have read page 58, they should have no difficulty in understanding that water vapor condenses back into a liquid when sufficiently cooled.

Questions (Page 58)

1. (*a*) Evaporates. (*b*) Water vapor or a gas. (*c*) Condenses.
2. In the ground, on the earth, in the air.
3. Cool it. The experiment with the metal cup showed this.
4. Drops of water appear on the outside. The pitcher is colder than the air around it. The air touching the pitcher is cooled. The water vapor in this air condenses on the pitcher, because cold air can hold less water vapor than warm air.
5. His glasses were cold. The warm air in the room that touched the glasses became cooler. Water vapor condensed from this air and collected on the glasses.

Why must plants have water? (Pages 59-61)

Concepts

1. Solid materials can be dissolved in liquids.
2. Water is needed to dissolve food materials before plants can use them.
    a) Dissolved food materials in the soil are carried into the plant when the water soaks into the roots.
    b) Sap, made mostly of water, carries food materials and food to all parts of the plant.
    c) The food material in a seed must be dissolved before the young plant can use it for growing.

Experiments and observations

PAGE 59: To observe a solid dissolving in a liquid.

MATERIALS: Glass of water, sugar (lump or teaspoonful), cloth.

PAGE 60: To observe how sap moves up in a plant through the stem.

MATERIALS: Stalk of celery, glass of water, red ink.

PAGES 60-61: To show that plants need water to grow.

MATERIALS: Two yards of white cloth, four dozen bean seeds, water.

Information for the teacher

PICTURE. PAGE 59. This is a view along the Salmon River in Idaho.

Procedure

Have the pupils actually perform the experiments and observations on pages 59, 60, and 61. Then, by discussing what happens and reading the text, they can check their own findings. Stress the fact that plants cannot use food unless it is dissolved in water.

Suggest that the class think up other experiments on dissolving. Try many things, such as salt, baking soda, cocoa, soap, and fertilizer to see if they will dissolve in water. Or sprinkle fertilizer on the top of the soil of two pots containing plants that are alike. Water one pot but not the other and watch what happens. Drop a lump of soil into a glass of water and later notice the color of the water. This shows that some materials in the soil have been dissolved in the water.

For additional activities that may be used in connection with this problem, see *Things to Do*, page 65, Nos. 4 and 8.

Questions (Page 61)

1. It dissolves the food materials that they need in the soil. It carries the food materials into the roots of the plant and up through the stem to the leaves.
2. It dissolves the food and changes it so that the tiny plant inside the seed can start to grow. Describe the experiment on pages 60-61 or a similar one with seeds.

3. Dissolves.

4. Yes. Plants could not get food materials that they need from the soil. They would not grow, and you would not get any food.

5. The seeds need the water to dissolve and change the food in the seeds so that the tiny plants in them can start growing.

6. (*a*) Water dissolves the necessary food materials in the soil. (*b*) Water carries the dissolved food materials into the plant through the roots. (*c*) Water carries the dissolved food materials to all parts of the plant. (*d*) Water is needed by seeds of plants to start them growing. (*e*) Plants could not grow without water.

7. It is a very dry region. Only near the river bank is there enough water in the soil to dissolve the food materials and carry them into the tree roots.

Why do animals need water? (Pages 62-63)

Concepts

1. Water is needed to make juices that dissolve and otherwise change food so that the bodies of people and animals can use it.

2. Water provides the liquid part of the blood, which carries food and oxygen throughout the body.

Information for the teacher

Picture. Pages 62-63. Animals from left to right: Abyssinian oryx, Grant's gazelle, giraffe, black rhinoceros, zebra, vulturine guinea fowls standing against a nest of termites.

Procedure

Have the children read pages 62-63. Stress the fact that water is needed by people and animals (1) to dissolve and change food and (2) to make blood, which carries food and oxygen throughout the body. Ask the class to tell how the blood in animals is like the sap in plants. To summarize, have the children give reasons why this statement on page 63 is true: "Without water, nothing could stay alive on the earth."

Questions (Page 63)

1. Almost every kind of animal must have water every day; animals need water to dissolve and change their food so that their bodies can use it; the blood of animals is made up mostly of water; blood carries food and oxygen to all parts of the body.

2. Your body must have certain juices to dissolve and change the food before it can be used. Water is needed to make the juices.

3. Dry.

Questions to answer (Page 64)

Picture: The window was very cold. Water vapor in the air touching the window condensed to make frost on the window.

1. He does not get enough oxygen. He cannot breathe; he cannot live without breathing.

2. The air above the earth is so thin that it does not have enough oxygen in it to support life.

3. Oxygen. Carbon dioxide.

4. Bubbles of air in the water give it a milky look.

5. If the water comes from wells, it comes from ground water down in the earth. It may also come from springs, lakes, rivers, streams, or reservoirs behind dams.

6. A desirable number is six or eight. Your body needs plenty of water for changing and dissolving your food so that you can use it. You need it to make blood to carry food and oxygen around in your body.

7. Wilted. The leaves droop, and the stem may bend over.

8. They may wilt, dry up, and die; or they may grow so slowly or stay so small that they do not ripen before the growing season is over.

9. They are more exposed to the air if they are hung up. The water goes off into the air more quickly.

10. Water evaporates more quickly when the air is dry. The wind blows away the air full of water that has come from the clothes and brings dry air that has room for more water next to the clothes.

Things to do (Page 65)

1. Probably by ventilation from windows or by fans run in connection with the heating plant. Ask the school engineer.

2. (*a*) Do an experiment similar to the one on page 48. (*b*) Melt something. (*c*) Boil some water away or let some liquid stand in an open dish or pan. (*d*) Freeze some water or let some melted paraffin harden.

3. See *Divers* or *Diving* in an encyclopedia.

4. The colored parts are the fibrovascular bundles. They will appear buried in the stem. (In the experiment on page 60, this is the reason you could not see the red lines up the stem from the outside if the stalk of celery that you used was a thick one.)

5. (*a*) A dandelion has a long, thick taproot that goes down farther into the soil than grass roots do. Grass roots spread out more, and they are nearer the surface of the soil. (*b*) Water is lost first from the top layer of soil during dry weather. The plant with deeper roots stays green longer.

6. Veins of leaves are easily seen.

7. The fruit should be heated at a low temperature. All fleshy fruits contain a large amount of water.

8. They have very small leaves or leaves reduced to spines so that water is not lost from them by evaporation. Sometimes the leaves and stems are fleshy, and water is stored in them. The plants can use this water during long periods when there is no rain. They have long root systems that spread out far from the plant, taking in all possible water. (See a general botany book or the children's encyclopedias.)

10. A general science book, a beginning chemistry book for high school, or the children's encyclopedias will supply this information.

UNIT 3. *How Does Your Body Work?*

Purpose and scope

The purpose of this unit is to explain how the human body works and not just to teach the structure of the body. The structure that is given is only that which is necessary for the child to understand why the human body can do what it does. The material in this unit furnishes the scientific background for the health units often taught in this and later grades. In fact this unit, together with Unit 7, furnishes appropriate material for the health course in this grade.

Science background

Discovering Our World, Book One: Unit 1, How Are the Things of the World Put in Groups? Unit 2, Why Do All Living Things Need Air and Water?

General concepts

1. The human body has many parts, each of which has certain work to do.
2. Knowledge of your body is necessary to keep it in good running order.
3. The skeleton supports and protects the softer parts of your body and gives it shape.
4. Joints and muscles make possible the movement of various parts of your body.
5. In your body is a group of parts that makes food usable by your body.
6. Food must be distributed throughout your body.
7. Certain body parts obtain oxygen from the air, and then the blood distributes the oxygen throughout your body.
8. Skin protects your body from dirt and germs and allows waste materials to escape.

9. Certain parts of your body keep it acquainted with what is going on around it.

10. Your body can send messages from one part of itself to other parts.

Introducing the unit (Page 67)

Information for the teacher

Picture. Page 66. Some of a group of children are putting together a chicken skeleton. From this activity, they are learning about bones and how a skeleton is formed.

Procedure

After the class has read the left-hand column on page 67, ask them for an answer to the question "What am I?" Then check back over the list of things that the machine can do to see whether the suggested one is the right answer. Then have the children read the rest of the section to see how the boys and girls in another science class answered the question. The pictures at the top of page 67 can be used in discussing things that the body can do.

How is your body like a machine? (Pages 67-69)

Concepts

1. Your body is somewhat like a machine. It has many parts that work together to make it run.

2. All human bodies have parts that are alike.

3. Your body needs food to make it run.

4. Your body must be kept in good condition in order to run properly.

5. Your body is different from a machine because it can do many things that a machine cannot do.

Procedure

Suggest that the class make a list of the ways in which the human body is like an automobile. Then read pages 67 and 68. The children might also tell all the things that their bodies have done since getting out of bed this morning. Have them check the things mentioned by reading page 69. Stress the fact that the human body can do more different things than any machine.

Questions (Page 69)

1. Food.

2. In order to understand how to keep your body in good condition so that it will run properly.

3. The worn-out parts of a machine can be replaced, or you can buy a new one; but you cannot buy a new body.

4. *Like:* Made of many parts; each part has a special thing to do; parts work together to make machine run; both need fuel to make them go; must be kept in good repair. *Different:* Some worn parts or injured parts can repair themselves; can think, hear, see, talk, etc.

How do your bones help you? (Pages 70-72)

Concepts

1. Your body has a framework made of bones called the skeleton, which holds it up and gives it shape.

2. The bones of the skeleton are held together by ligaments. Cartilage between the bones keeps them from grinding together when they move.

3. The bones protect the soft parts inside your body.

Information for the teacher

Pictures. Page 70. This is a large jellyfish that is commonly found on the Atlantic Coast from Maine to Florida. It is called the Moon Jelly and grows to be about a foot across. The picture shows one swimming near an old pile on which seaweeds and shellfish are growing.

Page 72. The skeletons shown are *top row:* fish, dog; *middle row:* frog, bird, snake; *bottom row:* alligator. The children should be expected to recognize the big group only, not the specific animal.

Procedure

Suggest that the children bring some bones to school. These may be obtained at the meat market, or found in woods and fields. The bones will help the pupils understand that bones protect and give shape to the body. Children can tell the shape of an animal such as a fish or chicken from its skeleton. The skull of an animal can often be found and will help pupils understand how bones protect the brain.

As the pupils are reading and learning about their own bones on pages 70-72, make frequent use of the picture on page 71.

Questions (Page 72)

1. Made of different kinds of bones. Small, round bones put together make the spine or backbone. Bones of the arms, legs, ribs, and head are attached to the backbone in such a way that the body has a definite shape.
2. Holds your body up and helps hold the rest of your body framework together.
3. The bones of the spine are held together by tough cords, or ligaments, that make it possible for the spine to bend.
4. By forming a hard case for the soft parts inside your body.
5. *Skull:* Bones of the head that protect the brain.

Skeleton: Framework of bones that holds the body up, gives it shape, and protects the soft parts of the body.

Cartilage: Also called gristle. A material that makes a little cushion between the bones of the skeleton and forms part of the nose and ears.

Ligaments: Tough cords that hold the bones together and make it possible to bend parts of the body.

Backbone: Also called spine. Made up of small, round bones with holes through them. Spinal cord runs up through them. Bones are held together by ligaments and have a small pad of cartilage between them. Holds up your body and helps hold the other parts of the framework together.

How can your body move? (Pages 73-75)

Concepts

1. Joints and muscles make it possible to move the various parts of your body.
2. There are joints in your body at every place where the bones can move.
3. Muscles are fastened to the bones and pull on the bones to make them move.
4. Most muscles work in pairs.

Information for the teacher

PICTURES. PAGE 74. *Top.* The red lines are the ligaments. The small bone in front of the knee is the kneecap.

Procedure

Have the class make a marionette or borrow one from another class to illustrate the idea of joints. As the children are reading about the joints and muscles of their own body on pages 73-75, have them feel and demonstrate these parts: elbow, shoulder, knee, ankle, finger joints, wrist, muscles of arms and legs. If possible, have the class carry on the activity suggested in *Things to Do*, page 89, No. 1.

Questions (Page 75)

1. To allow the parts of your body to move.
2. *Run:* knee, ankle, hip. *Chew:* jaw. *Swim:* elbow, shoulder, hip. *Write:* shoulder, elbow, wrist, finger. *Talk:* jaw. *Ride a bicycle:* hip, knee, ankle, elbow, wrist, shoulder.
3. Gets thicker and shorter.
4. So that you can move the bones in two directions. So that you can pull the bone back after moving it in a certain direction.

How does your body use the food you eat? (Pages 76-78)

Concepts

1. Food must be digested before the body can use it.
2. Teeth cut and grind food into small bits.

3. Saliva and other juices help digest the food.

4. In the stomach and intestines, the food is mixed, liquefied, and in other ways prepared for use in your body.

5. The digestive system should be kept in good working order.

Information for the teacher

Picture. Page 76. The diagram shows the second set or permanent teeth (thirty-two teeth in all). The teeth colored green are incisors. The first red tooth (from the front) on each side is the cuspid. The second two are the bicuspids. The first two blue teeth are the first and second molars. The third are the "wisdom teeth," or third molars. The children will, of course, not find these third molars in their mouths. In the pictures of individual teeth, the light-colored portion of the tooth is the root.

Procedure

As the children are reading about teeth on page 76, have them find these different kinds of teeth in their own mouths. If they see the tops of the teeth, they can easily distinguish between the cutting teeth, the tearing teeth, and the grinding teeth. Use the pictures of teeth on page 76 for reference. If a large chart or model is available, make use of that, too. Charts of the teeth are usually obtainable from tooth-paste companies. (See page 95 of the *Guidebook*.)

Have the pupils refer to the picture on page 77 while they read where the food goes after they swallow it. The fact that juices dissolve much of the food, thereby changing the solid food into a liquid, should be easily understood, as in the previous unit the children saw water dissolve sugar.

Questions (Page 78)

1. To grow; to repair parts of your body; to give strength to do things; to keep your body warm.

2. You eat food and then grow bigger.

3. Break it up and chew it into fine bits.

4. Saliva in your mouth moistens the cracker so that it can be swallowed.

5. Muscles of the stomach and intestines move the walls of these parts back and forth to help squeeze the food and break it up more. The juices dissolve and change the food that has been broken up.

6. Water is used to help make the juices needed to digest the food. Water is also a good dissolver, and the food must be dissolved before it can be used by your body.

7. Teeth break up the bread. Saliva moistens it and starts to digest it. It is swallowed and goes down the tube that connects the mouth to the stomach, where it is further broken up and mixed with a juice in the stomach. This changes it almost completely to a liquid. Then it goes to the small intestine, where more juices act on it. The liquid part passes through the wall of the intestine and goes to the other parts of your body. Any undigested part goes into the large intestine and is passed out of your body.

How is food carried to all parts of your body? (Pages 78-80)

Concepts

1. Food must be carried to all parts of your body.

2. The blood carries the food through blood vessels to all parts of your body.

3. Your heart keeps the blood moving.

Information for the teacher

Picture. Page 79. This diagram shows only the main blood vessels. A great branching system of blood vessels carries blood to all parts of your body. The largest blood vessels that carry blood from the heart are the *arteries*. The largest of these is the *aorta*, which leads out of the left side of the heart. This large vessel branches into smaller and smaller arteries. The smallest of these are known as *arterioles*. The arterioles branch to form even smaller tubes, the *capil-*

laries. These are the smallest of the blood vessels and have very thin walls. This allows the solutions carrying the oxygen and food to pass out to the cells around the capillaries. It also allows wastes from the cells, such as carbon dioxide, to pass into the capillaries to be carried off. The capillaries unite to form very small *veins.* These in turn unite to form larger and larger veins. Through these veins, the blood that has the carbon dioxide and other waste products is carried back to the heart and then to the lungs. In the lungs, the blood loses the carbon dioxide and gets a new supply of oxygen before going through the heart and starting around your body again.

Procedure

Have the class refer to the diagram of the blood vessels on page 79 while reading pages 78-80. The children should feel their hearts beat, as suggested on page 78. If a portion of a blood vessel is obtained from a meat market or from a killed chicken, the children get a better idea of just what a blood vessel is. See also *Things to Do*, page 89, No. 5. As the pupils read pages 78-80, have them write down the route of digested food to all parts of the body. This might be somewhat as follows:

1. Liquid food in small intestines passes through intestine walls into tiny blood vessels.
2. These tiny blood vessels in intestine walls join to make larger vessels, and these join with others to make still larger ones.
3. These large blood vessels carry the blood containing the food to the heart.
4. The heart sends the blood containing food through other blood vessels to every part of your body.

The children know from experience that blood is in every part of the body because there is bleeding in the slightest cut or scratch. By holding his wrist or "feeling his pulse," a child can feel the blood being pumped through that part of his body. See *Things to Do*, page 89, No. 6.

Questions (Page 80)

1. Every part of your body needs food to keep it going and in good condition.
2. Because it must be in liquid form to pass through the walls of the intestine into the blood vessels.
3. The big blood vessels branch to make smaller and smaller vessels until they are so small that they can go into the smallest part of your body.
4. The heart acts like a pump and keeps pumping the blood through your body.
5. They divide into smaller and smaller branches just as a tree divides to make smaller branches and then tiny twigs.

How do all parts of your body get oxygen? (Pages 80-81)

Concepts

1. When you breathe, air is taken into your body through the nose and goes to the lungs.
2. In the lungs, oxygen is taken from the air and passed into the blood to be carried to all parts of your body.

Information for the teacher

The parts of the lungs to which the text refers, though not by name, are as follows: The two large tubes into which the windpipe, or *trachea*, branches are the *bronchi.* The bronchi branch into smaller and smaller branches. The smallest of these branches are called *bronchioles.* The bronchioles end in a group of small sacs or pockets, called *alveoli.* The walls of the alveoli have capillaries. The oxygen coming down through the tubes from the large windpipe through the bronchi, and finally through the bronchioles, reaches the alveoli. The oxygen enters the capillaries in the walls of the alveoli and so gets into the blood. The red blood cells carry the oxygen in the blood stream.

Procedure

Suggest that the class reread the right-hand column on page 53 before beginning this problem. Then have them read the left-hand column on page 80. Have the children breathe in air through the nose and then push it out through the mouth. Have them hold their ribs as they breathe as deeply as possible. As they read the rest of page 80, have them refer to the diagram at the left on page 81. Then have the class retell the path the air takes from the nose to the pockets in the lungs.

The oxygen from the air in these tiny pockets gets into the blood in the same way that food gets into the blood from the small intestines. The walls of the air pockets are full of tiny blood vessels. Oxygen passes through the walls of the air pockets in the lungs into the tiny blood vessels. Then the blood carries it to every part of the body. Have the class read page 81 and refer to the diagram at the right. Then the children should be able to tell how oxygen gets from the lungs into the blood. To emphasize the importance of oxygen to the body, refer the pupils to *Things to Do*, page 89, No. 7.

Questions (Page 81)

1. Into the windpipe and down to the lungs.
2. From the lungs, through the walls of tiny blood vessels that are in the walls of the tiny air pockets in the lungs.
3. Oxygen passes from the tiny air pockets into the tiny blood vessels in the same way that liquid food passes through the walls of the blood vessels in the small intestine.

What does your skin do for your body? (Page 82)

Concepts

1. Your skin is a waterproof covering for your body.
2. Your skin protects your body from dirt and germs and allows some waste materials to escape from your body.
3. Your skin should be kept clean. Breaks should be protected so that germs cannot enter.
4. Perspiration is a waste that your body gives off through pores in your skin.

Information for the teacher

Proper care of your skin is treated in more detail in Unit 7, pages 164-165.

For burns, apply a paste of soda and water. This is often considered a more effective first-aid treatment for ordinary burns than grease.

Germ is a term applied to any microscopic organism that causes disease. This includes bacteria and other disease-causing fungi, protozoa, and various tiny worms. Viruses, which are now believed to be non-living, are also considered as germs.

Procedure

Have the children read page 82. Then they can tell of their experiences such as swimming in water, taking a bath in a tub of water, etc., to show that your skin keeps water out of the body. Most of them have had scratches, cuts, or burns about which they can talk and tell how these were cared for. If any of these injuries caused an infection, that will show how germs may get into your body.

Children can usually see pores in the skin on their face by use of a mirror. Bring out the fact that the skin all over your body has these pores. Many experiences can be told by the children of times they perspired freely such as during a ball game, a bicycle ride, running, cutting a lawn, etc.

The necessity of washing with soap and warm water after exercise to get rid of old perspiration and dirt as well as germs may be mentioned. A "Keep Clean" squad might be organized to check up on the personal cleanliness of all the children in the class.

Questions (Page 82)

1. Keeps water out of your body; keeps out dirt and germs; lets perspiration out.
2. Germs are tiny plants or animals that can make you sick when they get inside your body.
3. It helps keep the germs off your skin. It also gets rid of dirt and perspiration and helps keep the pores of your skin clean and open.

How do you know what goes on around you? (Pages 83-85)

Concepts

1. There are five senses that help you know what is going on around you.

2. Certain parts of your body provide the five senses.

   a) Your eyes give the sense of sight.
   b) Your ears give the sense of hearing.
   c) Your nose gives the sense of smell.
   d) Tasters in your mouth give the sense of taste.
   e) Feeling things with your hands and other parts of your body gives the sense of touch.

Information for the teacher

Care of and safety with the eyes and ears are treated in Unit 7, pages 162-163.

The tiny parts, or "tasters," in the mouth refer to the taste buds. These are found chiefly in the tongue, although some are located in the roof of the mouth, the pharynx, and the epiglottis. In the tongue, the taste buds are groups of cells embedded in the small projections of the covering of the tongue. These little projections make the tongue feel rough.

Each kind of taste sensation has its own kind of taste bud, located in certain areas of the tongue. For example, taste buds for sweet and salt tastes are at the front of the tongue. The large ones at the back of the tongue are for bitter tastes. Those for sour are along the edge of the tongue. Materials to be tasted must be dissolved before the taste buds can be stimulated by them.

Smell receptors in the nose control the sense of smell. Scientists have recently discovered that these smell receptors act as "broadcasters" sending out heat waves. Just as the body feels cold when it loses heat, the nose and brain record smell when the smell organs lose heat. The object that is smelled gives off a gas that is capable of absorbing rays of the same length as the heat waves given off by the nose.

Smells and tastes are often hard to distinguish. Many tastes depend on smelling, too, as anyone who has had a nose cold will recall. Feeling which comes from the ordinary sense organs in the mouth also enters in, such as the biting feeling of ginger.

The sense organs in the skin that give the sense of touch, pressure, heat, cold, and pain are of various kinds and are scattered over the surface of the body. These sense organs are either special receptors or just nerve endings in the skin. They are not evenly distributed. Some areas are much more sensitive than others. For example, the fingertips are more sensitive to touch than the back of the hand. Pain receptors are much more widely scattered than the areas sensitive to touch or pressure.

Procedure

Ask the class the question answered in this problem: "How do you know what goes on around you?" Then have the children read pages 83-85. The class should carry out the observation suggested in the third paragraph on page 83 and refer to the picture on that page. Have the children look at the eyes of others in the class. To observe the change in size of pupils, let one child stay in a dark closet for several minutes and have the others notice the difference in the pupils of his eyes before he goes in and after he comes out. Let him see the difference in a mirror.

Ask different children to demonstrate the use of their five senses. Children can usually tell interesting experiences of using one of the senses to tell what something is, such as finding a certain object in the dark by feeling objects near it and then finally the object. They also like to tell of fooling someone or of being fooled, such as being blindfolded and asked to pick up something that feels like worms but turns out to be pieces of cooked spaghetti.

Questions (Page 85)

1. Answers individual.
2. Sight, hearing, smell.
3. What shape, size, and color it is; how far away it is; what it is doing if it is alive.

4. Your pupils enlarge to allow more light to enter.

5. Hold your nose and taste a piece of onion while blindfolded.

6. Taste, smell, sight.

What keeps the parts of your body working together? (Pages 86-88)

Concepts

1. Your brain is the director of your body; it keeps the parts of your body working together.

2. Your body can send messages from one part of itself to other parts.

   a) The nerves are the message carriers.

   b) Some nerves carry messages from different parts of your body to your brain. Other nerves carry messages from your brain to different parts of your body.

Information for the teacher

An elementary psychology or general biology textbook will give further information on the nervous system.

Procedure

Encourage discussion while reading pages 86-88. Stress the fact that messages can travel along nerves in only one direction. Some nerves carry messages to the brain, and other nerves carry messages from the brain to different parts of the body. Have different children give examples of this, such as:

Suppose it starts to rain.

Eye nerves to brain—It is raining in the open window.

Brain to arm nerves—Better close the window.

or

Suppose you are at the bat in playing baseball.

Eye nerves to brain—The ball is wide—isn't coming near.

Brain to arm nerves—Do not strike at the ball—I do not want to strike out.

Eye nerves to brain—This ball is coming right where I can hit it.

Brain to arm nerves—Hit this ball as hard as you can—I want a home run.

or

Suppose you are on your way to school.

Ear nerves to brain—The last bell is ringing.

Brain to leg nerves—Run as fast as you can —I don't want to be tardy.

Also have the children discuss and give examples to show that the brain is an excellent director, as when a driver quickly turns his automobile to avoid an accident.

Questions (Page 88)

1. Your brain.
2. Inside your skull.
3. To keep the parts working together and to tell the parts what to do.
4. Along the nerves. Messages travel only in one direction along nerves. Some nerves carry messages from different parts of your body to the brain. Other nerves carry messages from the brain to different parts of your body.

Questions to answer (Page 88)

1. *Joints:* make it possible to bend parts of your body. *Heart:* pumps the blood around your body. *Muscles:* move parts of your body. *Lungs:* take in oxygen for your body. *Brain:* directs your body—keeps the parts of your body working together. *Teeth:* cut and break up the food into smaller pieces for digestion. *Skin:* covers your body and protects it. *Nerves:* carry messages from one part of your body to another.
2. It must be digested; that is, it must be dissolved and changed.
3. The blood is pumped around through your body by the heart. As it goes through the lungs, it picks up a supply of oxygen from the tiny air pockets. Then as the blood travels to all parts of your body, it carries the oxygen with it. At the same time, the blood is carrying the dissolved food that was picked up from the cells of the walls of the intestine. Both food and oxygen are unloaded all through your body as the blood flows through the different parts.

4. Reading, observing, asking.

5. Fingers, one of the joints at the elbow, knee, ankle.

6. Have a brain that can think, solve problems, make plans, etc.

7. The brain. Messages come into the brain and are sent out to the proper part of your body.

8. It is not easily broken up or dissolved so that it can be used by your body.

9. So that you will chew it into smaller pieces before you swallow it. This makes it easier for the juices in the stomach to digest it.

10. Both act as fuels.

11. Answers individual.

Things to do (Page 89)

1. Obtain a joint from a cow, sheep, pig, or chicken. (*a*) Inside is marrow. (*b*) Muscles are fastened with strong tendons. (*c*) Ligaments fasten the bones together. (*d*) Blood gets inside through blood vessels, which may be seen.

2. Individual activity.

3. See the text, page 77, and the answer to question 7, page 78.

4-5. Individual activities.

6. Your pulse can be felt in the wrist or in the neck under the jaw. Your pulse beats faster. As your heart speeds up its action, it can supply more food and oxygen to the parts of your body that need them.

7. When you jump up and down, you must take more breaths to renew the supply of oxygen in your blood. The strenuous exercise causes your body to use up the oxygen more quickly than usual.

UNIT 4. *Why Do We Have Days and Nights?*

Purpose and scope

The purpose of this unit is to show the importance of the sun and its relation to the earth in a very elementary way and to develop the most obvious result of the earth's moving—namely, alternate periods of light and darkness, or day and night; and also the changing seasons. No attempt is made to elaborate on the relationship at this level. However, certain broad understandings should be developed.

Though the purpose of this unit is not to give the causes of the seasons (as these concepts in general are too difficult for children of this age), the child should be aware of the fact that because the earth moves as it does, we have long days (summer) and short days (winter) during the year and that the long days are the warm days. The child should also begin to understand the method of discovery used by scientists through the ages, that is, careful observation and experimentation and accurate thinking. This unit lays the foundation for understanding much that is in the following unit of this book. It is also prerequisite to Unit 7 of *Discovering Our World, Book Three.*

Science background

Look and Learn: Unit 3, Days and Days

All Around Us: Unit 3, Sun, Wind, and Weather

General concepts

1. The earth gets its light and heat from the sun.

2. The earth is shaped like a ball.

3. The earth rotates on its axis.

4. Because the earth is a ball, only half of the earth is lighted at one time by the sun.

5. The turning of the earth on its axis causes day and night.

6. The earth's journey around the sun makes a year.

7. Seasonal changes in temperature are the result of changes in the amount of heat received from the sun.

Introducing the unit (Page 91)

Ask the children why we have days and nights. Write their answers on the blackboard. Then have the class read the introduction. Further answers should then be added. As the children study the unit, have them refer to these answers, see if they are correct, and correct them when necessary.

How does the earth get its light? (Pages 91-93)

Concepts

1. Many materials give off light if they get hot enough.
2. The sun is a huge ball of hot gases.
3. The sun looks small because it is so far away.
4. The sun is more than a million times as large as the earth.

Information for the teacher

PICTURE. PAGE 93. This shows the so-called *prominences* of the sun. These are outbursts of extremely hot gases that shoot out from the edges of the sun. Formerly they were visible through a telescope only during total eclipses of the sun. But now an instrument called the spectroheliograph permits them to be photographed whenever the sky is clear enough.

TEXT. The gases that make up the sun are not burning. They are merely heated to incandescence. The neon light is, perhaps, the nearest like this. In such lights, gases glow but do not burn.

The earth does not come closer to the sun because of the gravitational attraction of the heavenly bodies for each other and because of the tendency of the earth to swing outward as it travels around in a huge circle. (See *Discovering Our World, Book Three*, Unit 7, What Is the Universe Like?)

Procedure

Children should understand that if a thing is hot enough, it will give off light. A candle could be used to show this. Have the children feel the cold top of the candlewick before it is lighted. Then light the candle. The children know that it is now too hot to touch. Another good way to show this is to ask the children to feel an electric-light bulb that is not lighted. Then turn on the current to light the bulb. A few minutes after it has been lighted, ask a few children to touch it carefully. Now have the pupils read pages 91-93.

Every sentence in the paragraphs on page 92 about the heat of the sun is important in helping the child understand that the sun is a big ball of very hot gases. Do not permit the children to say that the sun is a ball of fire because that is not true. The gases in the sun are *not burning*. Instead, they glow and give off light as the filament in a lighted incandescent electric lamp does. The filament, however, is a solid, while the glowing materials in the sun are gases. Review what a gas is by having the pupils refer back to Unit 2 (page 49).

Stress the huge size of the sun and its great distance from the earth. Have the children compare the size of a tree a few feet away with one several blocks away. The trees may be about the same size; but the one several blocks away looks much smaller. Or have the children watch an airplane until it is a mere speck in the sky and finally disappears. The fact that the plane is only a few miles distant while the sun is 93 million miles away will help to develop the size and distance of the sun. Drawing circles as directed on page 93 to indicate the relative size of the sun and the earth also will help establish the concept of the immense size of the sun.

Questions (Page 93)

1. It gives off light as many materials do when they get hot enough.
2. Because it is so far away.
3. It gives us heat and light.

What is the shape of the earth? (Pages 94-96)

Concepts

1. The earth is shaped like a ball.

2. There are several ways of showing that the earth is shaped like a ball.

Experiment

Pages 95-96: To show that the earth is shaped like a ball.

Materials: Small boat, globe, table.

Procedure

Encourage the children to give their ideas of the shape of the earth. Then have the class read pages 94 and 95. Have the pupils take time to study the pictures on page 94, noting that in the one to the left where the boat is far out to sea, only about the top third of the boat can be seen while the lower sails and the hull of the boat near shore can be seen.

Be sure to have the class carry on the experiment with the toy boat as described on pages 95 and 96. If each child will observe the boat as it is moved toward him around the globe as well as along the table top, he is more likely to get the feeling of the roundness of the earth and see the significance of the observations and conclusions of some of the wise men of long ago.

Questions (Page 96)

1. Because the earth looks flat. It is so big that you can look miles away without seeing that the earth curves.

2. It shows how people discovered that the earth is round by watching ships come up over the curve of the earth. It shows that the earth is round because you see the top of the ship first and then the bottom.

3. People have traveled around the earth, starting at one place and reaching that place again without changing the direction in which they were traveling. People very high above the earth in airplanes or balloons have taken pictures which show that the earth curves.

How does the earth move? (Pages 96-98)

Concepts

1. The earth's axis is an imaginary line through the earth.

2. The earth rotates on its axis.

3. The earth rotates from west to east.

4. The ends of the axis are called the North and South Poles.

Experiment

Page 97: To show what turning on an axis means.

Materials: Globe, top, orange, stiff wire, quarter or other coin.

Procedure

To understand that the earth turns on its axis, the children should carry on the activities on page 97. Have them see the spinning of a top, the turning of a globe, the rolling around of an orange in various directions, and the spinning of the orange in one direction around the wire. They should then understand that the wire is the axis on which the orange turns. By spinning a quarter, they can see how an object can keep turning in the same direction on an imaginary line as does the earth. If time permits, have them spin other things such as a plate, a pie pan, etc. While the children are reading and discussing pages 96-98 and carrying on the activities showing that the earth turns on its axis, have them use the word *axis* as often as possible so that it will become part of their vocabulary. Also, have the class find the North Pole and the South Pole on a globe. They should observe that the globe turns on an axis that passes through these poles.

Questions (Page 98)

1. Spinning around in the same place. Turning around a real or imaginary line that runs through the thing that is spinning.

2. By running a stiff wire or something similar through the orange, and turning the orange around on the wire.

3. Because it turns around in the same place and does not turn this way and that as the orange did before the wire was put through it.

4. The ends of an imaginary line that runs through the earth.

Why do we have daylight and darkness? (Pages 98-100)

Concepts

1. It takes twenty-four hours for the earth to turn once on its axis.
2. Because the earth is a ball, only half of the earth is lighted at one time by the sun.
3. The turning of the earth on its axis causes day and night.

Experiment

Pages 98-99: To show why we have day and night every twenty-four hours.

Materials: Globe, flashlight, chalk.

Procedure

Now the children should have the basic understandings necessary to answer the original question: "Why do we have daylight and darkness?" These three concepts are listed again on page 98, and the teacher should help the children see the relationship between them. Be sure to have the children perform the experiment on pages 98 and 99. This shows (*a*) why we have daylight and darkness, (*b*) why we have morning, noon, and evening, (*c*) the fact that the earth turns on its axis from west to east; the sun does not travel across the sky.

Have the pupils read the text to check their findings. They should now compare the reasons they gave to explain the cause of daylight and darkness with the facts they have learned. The answers given at the beginning of the problem should then be corrected.

Questions (Page 100)

1. (*b*), (*c*), (*d*), (*f*).
2. Seven.
3. Answer should show an understanding of the correct statements in question 1 and the ability to place them in the proper order.

How is the earth like a clock? (Pages 100-103)

Concepts

1. The sun is used for telling time.
2. When the sun is highest in the sky, it is twelve o'clock noon.
3. We watch the sun and the stars to see how far the earth has turned on its axis.
4. Since the earth is turning on its axis from west to east, you must turn your watch ahead when you travel from west to east, and back when you travel from east to west.

Experiment

Page 102: To find out whether it is twelve o'clock noon everywhere in the United States when it is twelve o'clock noon in Washington, D.C.

Materials: Globe, flashlight.

Information for the teacher

In passing from the Atlantic coast to the Pacific coast in the United States, a traveler goes through four time zones or belts, each extending through fifteen degrees of longitude. The *prime meridian* for the world (zero degrees) runs through Greenwich, England. Distance around the world is measured east and west from the prime meridian. Time in the easternmost zone in the United States is Eastern Standard Time. Next, to the west, is Central Standard Time. West of that is Mountain Standard Time. On the west coast is Pacific Standard Time. The boundaries of the different zones are irregular because, in operating the railroads, it was found more convenient to change time at certain stations. For the boundaries of the zones, consult a map such as the one in *Everyday Problems in Science*, page 438, or in an atlas.

Procedure

With the study of telling time by the sun, an activity should be carried on to show the ways in which people told time before they had clocks. These will include the use of the sundial, knotted rope, painted candle, water clock, and sandglass. The children will learn about sun time if they make a simple sundial and record the time as indicated in *Things to Do*, page 111, No. 2. Suggest to the children that they tell stories of their own or others' experiences in telling time by the sun.

The children should use the flashlight and the globe to see why it cannot be noon in all the cities at the same time. By doing this simple experiment, they should have the basic understanding clearly established for later study of the time zones in the United States. Likewise, they should be able to figure out whether they are to turn a watch back or ahead when traveling across these time zones. Have the class read the text and discuss the pictures at the top of pages 102 and 103. See also *Things to Do*, page 111, Nos. 1 and 4.

Questions (Page 103)

1. The earth turns on its axis once in twenty-four hours. By looking at the sun or stars, we can tell how far it has turned or how many hours have passed. When the earth has turned halfway, twelve hours have passed. So we say it is twelve o'clock. When the sun is directly overhead, it is twelve o'clock noon. We figure out the rest of the time from that.
2. Because the sun is not directly overhead all over the country at the same time. When it is overhead in Washington, D.C., it is lower in the sky in the west. So that when it is twelve o'clock in Washington, it is only eleven in Chicago, and so forth.
3. Once. Twenty-four.

What makes a year? (Pages 104-105)

Concepts

1. A year is the time that it takes the earth to travel, or revolve, once around the sun.
2. Each year is divided into four seasons, one for each quarter of the distance around the sun.

Information for the teacher

The picture of the earth revolving around the sun shows that the earth slants on its axis. However, this fact and the relation of the slant to the seasons, etc., has not been entered into, since it is unnecessarily difficult for this grade level. It is treated at a higher level in the science program.

Procedure

The children can use a lamp for the sun and a globe for the earth. After reading the text, ask them how these objects should be used to represent the movement of the earth to make a year. A child will probably pick up the globe and carry it once around the lamp. He then needs to be reminded that the earth is constantly spinning on its axis, so he must keep spinning the globe as he walks completely around the lamp. (To make the dramatization accurate, the globe would need to be turned around on its axis 365¼ times while it is moving once around the lamp.) Let the class study the diagram showing the two movements of the top. The earth likewise moves in these two ways.

The seasons are mentioned here to give the child a better understanding of a year, as he is familiar with winter, spring, summer, and autumn. They are also brought in to make clearer the fact that as the earth revolves around the sun once, we have the four seasons. During each season, the earth has traveled one fourth of its journey around the sun.

Questions (Page 105)

1. Rotates on its axis and revolves around the sun.
2. Rotating on axis gives days. Revolving around sun gives years.
3. Answers individual.
4. 365¼.

How do the hours of daylight and darkness change during the year? (Pages 105-106)

Concepts

1. Summer days have more hours of daylight than winter days.

2. Daylight begins when we first see the sun in the east and ends when we no longer see the sun in the west.

Information for the teacher

The verse is from the poem "Bed in Summer" by Robert Louis Stevenson.

Procedure

Have the pupils read pages 105-106. Then let them tell how their activities in summer and in winter differ because of the length of day. The class should also keep a record of daylight and darkness. This furnishes an excellent opportunity for the children to record data and draw conclusions from them. The chart on page 106 may be used as a guide. Charts may also be made giving the time of sunrise and of sunset on the first day of each month for the remainder of the school year. This information can be found in newspapers, almanacs, and sometimes on calendars. See also *Things to Do*, page 111, Nos. 5 and 6.

Questions (Page 106)

1. May, June, July, August.
2. November, December, January, February.
3. Answers individual.
4. March, April, September, October.

Why are summer days warmer than winter days? (Pages 107-109)

Concepts

1. Because the days are longer in summer, we get more heat from the sun.

2. Because the sun is more nearly straight overhead in summer, the earth gets more heat.

Experiments

PAGE 107: To find out if slanting rays of light affect the brightness of the spot of light made by the rays.

MATERIALS: Flashlight, cardboard tube or some heavy paper.

PAGES 108-109: To find out how changes in the position of the light change the shadows.

MATERIALS: Yardstick, light.

Procedure

Have the class perform the experiment with the flashlight inside a cardboard tube. It should be brought out that the spot where the light is directly above is brighter and warmer. The days when the sun is highest in the sky and nearly directly overhead are the warmest. If a chalk mark is drawn around the outline of the two spots, their difference in size can be easily seen. Now have the pupils read to the end of the problem.

Children enjoy seeing their shadows, and they can learn much from the length of their shadows. Hold an electric light high near the center of the room. Ask a child to stand directly under it. His shadow will, of course, be short. Then move the light to one side and keep lowering the light. Of course, the lower the light, the longer the shadow will be. It is the same with shadows made by the sun. A short shadow shows that the sun is high in the sky. A long shadow shows that the sun is low in the sky. In summer, the sun is higher in the sky and more directly overhead than in winter. Therefore, summer shadows are shorter than winter shadows at the same time of day.

The children might also keep a temperature chart showing the temperature at a given time on a certain day each week for the remainder of the school year. Then they can compare it with the chart of hours of daylight and darkness. They can see that the longest days are the warmest and that the shortest days are the coldest. This will emphasize the fact that the sun gives us heat and light. Therefore, the longer the sun shines on a certain spot on the earth, the warmer the day will be.

See also *Things to Do*, page 111, No. 3.

Questions (Page 109)

1. There are more hours of daylight in summer than in winter; the sun is more directly overhead in summer than in winter.

2. Your shadow is shortest when the sun is most directly overhead.

3. Shortest in summer; longest in winter.

Questions to answer (Page 110)

1. They learned that the earth is round and that it spins on its axis. This made them able to understand what makes day and night. They learned that it was the earth that is moving and not the sun.

2. (*b*), (*c*), (*f*).

3. *Baseball players:* When it gets dark early, the baseball game sometimes must be called off before it is finished because the players cannot see.

Farmers: Farmers get up very early to milk their cows, etc. When the days are longer, they do not have to get up in the dark or do not have to work so long in the dark.

Milk-wagon drivers, newsboys: These people also start their work early and the more daylight there is, the less time they spend working in the dark. Newsboys delivering the evening papers can do so in daylight when the days are longer.

4. Answers may include: it would be cold; it would be completely dark; plants would not grow; there would be no food; no one could work or play; all living things would die.

5. The sun appears to rise in the east and set in the west. That is, we see it first in the east and last in the west. This means that the east comes in sight of the sun before the west.

6. Arrive at answer by multiplying the number of years old by 365¼.

7. So that the trains will run on time. People would miss the trains if they did not arrive when the timetable says that they will. Trains would run into each other if the railroad men did not know exactly what time it is.

Things to do (Page 111)

1. Some jewelers have clocks that are connected with the telegraph service so that the time is kept correct at all times.

2-3. Individual or class activities.

4. Any of the children's encyclopedias will give this information. Sundials are still in use, though chiefly for ornament. Small hourglasses are in wide use as egg timers and for timing telephone conversations in the home.

5. The days of most and least daylight will generally be June 21 and December 21, respectively, three years out of four. The fourth year, it will usually be the 20th of those months due to leap year. (See an almanac for the summer and winter solstices for any particular year.)

6. When the sun crosses the equator in spring (vernal equinox) and in fall (autumnal equinox), hours of daylight and darkness will be the same. The dates, again, will vary but usually will be March 21 and September 23.

UNIT 5. *What Can We See in the Sky at Night?*

Purpose and scope

Children are extremely interested in the stars and other heavenly bodies. Through the study of this unit, they will find many of their questions answered. The stars, moon, and planets that they see in the sky will take on meaning. Understanding will replace hazy and erroneous ideas.

Certain comics and radio programs involving the heavenly bodies are imaginary and are not based on facts. After studying this unit, pupils should be able to distinguish between fact and fancy. They should begin to appreciate information about the heavenly bodies that has been acquired after long and careful study by scientists.

No attempt is made in this unit to treat the universe as a whole. However, the unit builds a foundation for a more detailed discussion in *Discovering Our World, Book Three*, Unit 7, What Is the Universe Like?

Science background

Discovering Our World, Book One: Unit 2, Why Do All Living Things Need Air and Water? Unit 4, Why Do We Have Days and Nights?

General concepts

1. A star is a ball of hot gases.
2. When materials are heated very hot, they give off light.
3. Groups of stars are called constellations.
4. The constellations seem to move in the sky because the earth turns on its axis.
5. The moon is nearer to the earth than anything else in the sky.
6. The moon is not hot like the sun; it gives light by reflecting sunlight.
7. The moon appears to change its shape because we cannot always see all of its lighted part.
8. Planets differ from stars in that they do not give off light and they travel around the sun.
9. The earth is a planet.
10. Shooting stars are really meteors.

Introducing the unit (Page 113)

Have the children read the two paragraphs at the top of page 113. Then encourage the children to ask questions about the heavenly bodies that they see in the sky at night. The questions should be written on the blackboard. Then as the unit progresses, more questions can be added to the list. When the answer to a question is found, it can be written opposite the question. The children should be made aware of the many ways to find the answers to their questions, such as performing experiments, making observations of the sky at night, and reading.

What is a star? (Pages 113-115)

Concepts

1. A star is a ball of hot gases.
   a) Our sun is a star.
   b) Many stars are much larger than our sun.
2. When materials are heated very hot, they give off light.
   a) Materials change color with changes in temperature.
   b) Stars have different colors because they differ in temperature.

Experiment

PAGE 114: To show that materials change color when they are heated.

MATERIALS: Steel knitting needle or piece of iron wire about a foot long, pair of pliers, hot flame.

Information for the teacher

PICTURE. PAGE 114. The man in the picture is looking at the steel through an instrument called an *optical pyrometer*. (A pyrometer is a thermometer for measuring high temperatures.) With this instrument, he can determine the temperature of the slab of steel.

Procedure

One question almost universally asked is "What is a star?" This question furnishes an excellent lead into the first problem. After the pupils have read the introduction, have them recall from the previous unit all that they have learned about the sun. This information should be written on the board somewhat as follows:

1. The sun is a huge ball of very hot gases.
2. The sun gives off heat and light.
3. The sun is more than a million times as large as the earth.
4. The sun is 93 million miles from the earth.

Then the class should read to the end of the paragraph that begins on page 113. Have the pupils look over the list and find out whether all the items describe a star.

Item 1 checks: Stars, like our sun, are balls of hot gases.

Item 2 checks: Stars, because they are balls of glowing gases, give off light as our sun does.

Item 3 checks: Stars are very large, too, many of them being much larger than our sun.

Item 4 checks: The stars are much farther from the earth than our sun. A star is so far away that it looks like a tiny point of light.

Such a procedure should help the pupils grasp the ideas that stars are suns and that our sun is a star. Then this information should be added as items 5 and 6 to the list on the board.

If possible, have the class perform the experiment given on page 114 to show that the steel knitting needle or iron wire changes color as it gets hotter and hotter. The children can also observe that the wires in an electric toaster or electric heater become red-hot. The filament in an electric lamp becomes even hotter and glows with white heat.

Urge the children to look at the stars to see if they can find any red or bluish-white ones. They should be warned that these colors will not be brilliant. Many of the stars that they see will look yellow, but they are apt to find one star that is red and one that is bluish-white. See also *Things to Do*, page 137, No. 7.

Questions (Page 115)

1. It is a ball of very hot gases.
2. Not so hot as a bluish-white star but hotter than a red star. Because materials that are heated until they are yellow are hotter than materials that are heated until they are red, but they are cooler than materials that are heated until they are bluish-white.
3. The gases in the sun have been heated until they are hot enough to give off light.
4. They are much farther away than the sun.
5. Bluish-white, yellow, red.

What is a constellation? (Pages 115-121)

Concepts

1. Groups of stars are called constellations.
2. The stars and constellations have names.
3. Knowing the stars can help us find directions.
4. The Milky Way is made up of millions of stars.

Information for the teacher

Monthly star charts and information about how to find the stars and constellations can be found in some of the science magazines such as *Nature Magazine* and *Junior Natural History*. (See Bibliography, page 85.) The latter is especially helpful for this grade level since the charts are simplified.

Procedure

Have the class read pages 115-117 about the stars that form the Big Dipper and Little Dipper. After the children have enjoyed the story of the Big Bear and Little Bear, help them find stories about other constellations as suggested in *Things to Do*, page 137, No. 2.

Then have the pupils read page 118 and the first paragraph on page 119 to learn how to find the North Star (Polaris), Little Dipper, and the Big Dipper. Use the pictures on pages 116 and 118. Urge the children to look for these stars in the sky before bedtime.

Have the children read the next paragraph on page 119 and then find Cassiopeia in the picture on page 118. Refer the pupils to the list of Science Words at the back of the book for the pronunciation. Pronounce the word several times so that the class can say it correctly. Encourage the pupils to look for this constellation in the evening sky. At this point, some star charts of the constellations Big Dipper, Little Dipper, and Cassiopeia in the northern sky should be made, as suggested in *Things to Do*, page 137, No. 3.

Now have the class read the rest of pages 119 and 120 down to the last paragraph on page 121 about the constellation Orion in the southern sky and about two bright stars in it, Betelgeuse and Rigel. Have the class find out how to pronounce them by looking in the list of Science Words. Again pronounce the words several times. The pupils should use the pictures on pages 120 and 121 to locate Orion and find each of these stars in it. Encourage the children to look for these stars in the southern sky at night. On a clear night, the stars in Orion are so bright that the children should have little difficulty in finding it. Have charts made of Orion and the southern sky, as suggested in *Things to Do*, page 137, No. 4. After the pupils read the last paragraph on page 121, they can easily find the Milky Way extending across the sky from north to south. Stress the fact that when they are looking at the Milky Way, they are seeing many millions of stars. The class may wish to carry out the activity suggested in *Things to Do*, page 137, No. 9.

Questions (Page 121)

1. *Big Dipper.* Face north and look at the sky.

Little Dipper. Follow the line made by the two "pointers" in the Big Dipper down to the North Star. This star is the first star in the handle of the Little Dipper.

Cassiopeia. Look in the northern sky and hunt for a constellation that looks like a big letter W.

Orion. During the winter months, look in the southern sky. Look for three bright stars in a row. This is Orion's belt. Then you can easily see the rest of the constellation.

2. See the picture on page 118.

3. See the picture on page 120.

4. *Southern sky:* Orion, Little Dog, Great Dog.

Northern sky: Big Dipper, Little Dipper, Cassiopeia.

5. *Constellations:* Group of stars that seem to make the shape of something; have names; stories about many of the constellations.

North Star: Always in the north; almost straight above the earth's North Pole; also called *Polaris*.

Orion: Large constellation containing two of the brightest stars in the sky; seen in the southern sky in winter; supposed to represent a hunter with his sword and shield.

Why do the constellations seem to move? (Pages 122-123)

Concept

The constellations seem to move in the sky because the earth turns on its axis.

Experiment

PAGES 122-123: To find out why the stars are seen in different parts of the sky.

MATERIALS: Globe, dark blue or black umbrella, white paint or chalk.

Information for the teacher

This problem does not try to explain why most of the constellations can be seen for only a few months during the year. If the class wishes to know, you might liken the path of the earth around the sun to a race track. If you ride around a race track, you see different things along the track as you pass by, such as the starting post, the grandstand, a group of friends, some flags, a tall tree, etc. The same is true with us on the earth as it is racing along its path around the sun. We can see one constellation and then another; and so on as we go around. This is because the earth revolves around the sun.

It is incorrect to say that the stars do not move. They are moving at great speeds. However, their relative positions do not change for thousands of years. Thus they appear not to move at all.

Procedure

Children may ask why a constellation is not in the same place at 10 P.M. as when they saw it at 7 P.M. By reading pages 122 and 123, they can find the answer. The experiment with the umbrella held at the North Pole of the globe shows, in a simple and understandable way, that the stars are seen in different places in the sky on the same night because the earth turns on its axis. Let each child stand beside the cardboard figure and look up at the constellations painted on the umbrella as the globe is turned and the figure moves with it.

Questions (Page 123)

1. Because the earth is moving.
2. How the stars can be used as a clock. That the constellations appear to move.
3. If the Big Dipper moved the way the hour hands on a clock move, 6 o'clock in the evening would be where 6 o'clock in the morning is. Noon and midnight would also be in opposite positions.

How is the moon different from the stars? (Pages 124-125)

Concepts

1. The moon is nearer to the earth than anything else in the sky.
2. The moon is not hot like the sun; it gives light by reflecting sunlight.

Procedure

Ask the pupils what they would like to know about the moon. List their questions on the blackboard. Then, in so far as possible, have the children find their own answers as they study the next three problems dealing with the moon.

Have the pupils read pages 124-125. Be sure that they understand what *reflect* means. Let them use a small mirror to reflect light as suggested on page 124.

Questions (Page 125)

1. Throw back.
2. Not hot; does not give off its own light but reflects sunlight.
3. Light from the sun strikes the moon, and the moon reflects this light.
4. Metal has a lighter, smoother surface than the road. So it reflects light better than the road does. (See the picture on page 124.)

What is the moon like? (Pages 125-126)

Concepts

1. There are mountains, valleys, and plains on the moon.
2. There are no living things on the moon because there is no air or water.

Procedure

Have the pupils read pages 125-126. Let them examine and discuss the picture on page 125. The pictures on pages 126-127 also show the surface of the moon. An interesting activity is suggested in *Things to Do*, page 137, No. 1.

Questions (Page 126)

1. There is no air nor water on the moon.
2. When sunlight strikes high mountains on the moon, it makes big, long shadows.
3. Mountains, shadows.

Why does the moon seem to change its shape? (Pages 127-129)

Concepts

1. The sun lights only half of the moon because the moon is shaped like a ball.
2. The moon appears to change its shape because we cannot always see all of its lighted part.

Experiment

PAGE 128: To find out why the moon seems to have different shapes.

MATERIALS: Bright light, ball.

Information for the teacher

PICTURES. PAGES 126-127. The apparent changes in the shape of the moon are known as *phases* of the moon. These photographs, taken at Yerkes Observatory, show the moon at different ages. (Age of the moon is figured from the time when the moon was dark, that is, the time of the true new moon.) From left to right these ages are: three and one-half days (young crescent moon); five days (first quarter or half moon because one-half of the lighted side is seen); nine and three-quarters days (gibbous moon, three-quarters full); sixteen days (full moon); eighteen and one-half days; twenty-two and one-half days (last quarter); twenty-four days (old moon).

TEXT. If the experiment described on page 128 is done, the reason why the horns of the young crescent moon and the old moon point in opposite directions will be clear.

This experiment is designed to show how the moon appears when it is in different positions in relation to the sun and the earth. The moon does not travel in an orbit around the earth in the way that the earth travels around the sun. The moon is traveling in its own orbit around the sun. The orbit of the moon crosses back and forth across the earth's. Because of this and because of the speeds at which the two bodies are traveling about the sun, the moon *appears* to be revolving about the earth. It is not necessary to attempt to explain this, but children should not get the idea that the moon revolves around the earth in the same way that the earth revolves around the sun. For further explanation of the phases of the moon and the movement of the moon, consult a general science textbook or one of the books listed in the Bibliography, page 85 of the *Guidebook*.

Procedure

Have the class read page 127 and discuss the pictures on pages 126-127. Then have the pupils do the experiment on page 128. The pictures on pages 128-129 show how to do the experiment. The pupils' drawings should resemble the pictures on pages 126-127.

Questions (Page 129)

1. The moon seems to change its shape because we cannot see all of its lighted part all the time.
2. *Moon:* (*a*), (*c*), (*d*), (*e*). *Star:* (*b*).
3. About twenty-eight days, or four weeks.
4. Answer depends on calendar.

What is a planet? (Pages 130-133)

Concepts

1. Planets reflect light from the sun as the moon does.
2. Planets travel around the sun.
3. The earth is a planet.
4. There are nine known planets.
5. The planets are at different distances from the sun.
6. For each planet, a year is the time that the planet takes to go around the sun.

Information for the teacher

PICTURES. PAGE 130. The path that a planet travels around the sun is called its *orbit*. The orbits of the earth and the other planets are elliptical rather than circular. Some are more nearly circular than others. Venus has the most nearly circular of the orbits. This picture is, of course, diagrammatic and does not attempt to show the orbits exactly.

PAGE 131. Venus takes 584 days to go through its phases.

PAGE 132. The colored bands on Jupiter are known as the belts. They vary from time to time in intensity of color and width. Though a constant characteristic, the cause of these belts is not known. The rings of Saturn are made up of millions of tiny particles in layers not more than ten miles thick.

TEXT. A more detailed treatment of the planets and the solar system will be found in *Discovering Our World, Book Three*, Unit 7. Pluto, the last planet discovered, was first seen in 1930. Magazines such as *Nature Magazine* and *Junior Natural History* tell what planets are visible each month and how to locate them.

Procedure

Have the pupils read and discuss pages 130-133, making use of the pictures. Encourage the class to carry out the activity suggested in *Things to Do*, page 137, No. 6. Stress the fact that scientists are continually discovering new things. Because of this, scientists are very careful not to say that something is true until they have a great deal of proof. That is why a statement made by scientists is likely to be true.

Questions (Page 133)

1. (*a*) They reflect light as the moon does; they do not make their own light. (*b*) They travel around the sun.

2. Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto.

3. One of the planets was discovered only a few years ago. Others may still be discovered.

4. (*a*) Mercury; (*b*) Saturn; (*c*) Venus; (*d*) Venus; (*e*) Pluto; (*f*) Jupiter; (*g*) Pluto.

Are there living things on the planets? (Pages 133-134)

Concepts

1. Scientists do not know whether or not there are living things on any planet besides the earth.
2. Some scientists believe that there may be living things on Mars.

Information for the teacher

Picture. Page 134. *Right.* The white area at the top of Mars is one of the polar caps. There is one at each pole. They change in size as the seasons change on Mars.

Procedure

Have the pupils read and discuss pages 133-134. They will probably be very interested in reading these pages, because they may read stories or hear radio programs about people from other planets. This problem will help pupils distinguish fact from fancy in stories they read in the comics, or hear over the radio.

Questions (Page 134)

1. They are so far away from the sun.
2. It seems to have some kind of air; sometimes has seasons; looks green; possibly has plants.
3. Air and water.

What are shooting stars? (Pages 134-135)

Concepts

1. Shooting stars are really meteors.
   a) They travel toward the earth at great speed.
   b) They get hot and glow when they reach the air around the earth.
2. A meteorite is a piece of meteor that has fallen to the earth.

Information for the teacher

Picture. Page 136. This is the Willamette Meteorite, the largest found in the United States (15½ tons). It is now in the American Museum of Natural History, New York City.

Text. In spite of the great numbers of meteorites that fall and the number that strike the earth, very few have done damage to buildings. Since 1790, only eleven have struck and damaged buildings. Of these only three were in the United States. There have been no authenticated cases of a meteorite striking or injuring a human being.

Procedure

The pupils should read and discuss pages 134-135. Have them refer to Science Words for the pronunciation of *meteor* and *meteorite.*

After these pages have been studied, the children will know that "shooting stars" are not stars at all; and so they will not be frightened if they see a meteor streaking through the sky.

For an additional activity, see *Things to Do*, page 137, No. 8.

Questions (Page 135)

1. Shooting stars are solid objects traveling through the sky. They do not give light until they reach the air around the earth.
2. Rock, iron, or mixtures of rock and iron.
3. Burns up or falls to earth.
4. Answers to this question may usually be obtained from newspaper files, the state geological department, or possibly some long-time resident of the area.

Questions to answer (Page 136)

1. Look at them, using telescopes and other instruments such as cameras on the telescopes; watch them to see how they change position in the sky, etc.
2. (*a*) Mars; (*b*) Moon, Venus; (*c*) Sun, Moon; (*d*) Sun; (*e*) Sun; (*f*) Planets, Moon.

3. You can always find directions if you can find the North Star, because it is always in the north.

4. *Venus:* almost same size as earth; brightest planet; seems to change shape; is sometimes morning or evening star; year is 225 of our days.

Big Dipper: also called the Big Bear, or Ursa Major; found in the northern sky; two stars in the bowl point to the North Star; can be used as a clock because it moves around the North Star.

Mars: farther out from the sun than the earth; smaller than the earth; looks red; its year almost twice as long as the earth's year; may possibly have some life on it.

Betelgeuse: very bright star in constellation Orion; reddish in color; many times larger than our sun.

Reflect: means throw back.

Moon: object in the sky that is nearest the earth; seems to change shape; reflects light of the sun; has no air or water; has mountains, valleys, and plains.

Pluto: most recently discovered planet; farthest out from sun; very cold; cannot be seen without a telescope; takes 250 of our years to go around the sun once.

5. As they looked at the stars, they seemed to see shapes outlined by the stars.

6. Moon reflects only small part of light given off by the sun.

7. Sunlight is much brighter than light from the stars because the sun is much nearer to the earth.

8. Locate the North Star and face north. West would then be on the left and east on the right. South would be directly back of you. Then if you knew in what direction the place you were trying to find was, you would know which way to turn.

Things to do (Page 137)

1. Individual activity.

2. See the list of books on astronomy in the Bibliography, page 85. These books and elementary encyclopedias will give the names of some of the constellations not discussed in the text. They will also give stories about some of these constellations. Many of the stories will also be found in collections of legends from Greek mythology.

3-4. Refer to the pictures on pages 118 and 120. Cardboard or wrapping paper can be used for the charts. The children should use round shapes for the stars instead of the conventional pointed shapes, because the round shapes will help the children remember that stars are really big balls of glowing gases.

5-8. Individual activities.

9. Different colors of Christmas-tree bulbs can be used. Most stars will be represented with yellow bulbs. A red bulb can be used for Betelgeuse, and a blue one for Rigel.

UNIT 6. *What Can Magnets Do?*

Purpose and scope

An important purpose of this unit is to help the children use the scientific method. Every pupil has a chance to observe, experiment, and draw conclusions. The teacher should make the most of the many opportunities that require careful experimentation and the drawing of conclusions only after there is sufficient evidence to justify the conclusion.

This unit also offers opportunity for children to have fun. While "playing" with the magnets, the pupils will get many of the concepts firmly fixed in their minds. The magnets and other materials used in the experiments should be left where the children can easily use them during many periods of the day. The children should be encouraged to plan experiments of their own in addition to those given in the text.

They will also enjoy making various toys and games using magnets, as suggested in *Things to Do*, page 155, Nos. 4 and 5.

Since this is the first treatment of magnetism in the *Basic Studies in Science* program, only the most elementary concepts are included. The electromagnet is not discussed at this grade level, because some knowledge of electricity is required for an adequate understanding of it.

General concepts

1. Magnets attract iron and steel.
2. The force of a magnet will pass through many things.
3. The places where the force is strongest in a magnet are called the poles.
4. Every magnet has two poles, a north pole and a south pole.
5. A freely swinging magnet will point in a north-and-south direction.
6. Like poles of magnets repel each other; unlike poles attract each other.
7. The earth acts like a huge magnet with north and south magnetic poles.
8. The needle of a compass does not point exactly north because the geographic poles and the magnetic poles are not in the same places.

Introducing the unit (Page 139)

If the teacher holds up a magnet before the class and asks what it is, many of the boys will know that it is a magnet. Then if she asks what a magnet can do, the replies will show that they have only a little information. If, however, she asks if the class would like to learn about magnets, she is likely to get a unanimous "Yes." This response will serve as a motive for beginning the unit.

A dramatic way to start the unit is to have a child make the magnetic toy boat described on page 139. He can pull this around in a pan of water by using one end of another magnet. Or by using the other end of the magnet, he can push the boat away. This, of course, will arouse the curiosity of the children. They will want to know how this happens, and so they will be anxious to read page 139.

What kinds of magnets are there? (Page 140)

Concepts

1. Magnets are of different shapes.
2. Most magnets are made of steel, but some are made of a mixture of certain other metals.
3. Lodestone is a magnet found in the earth.

Information for the teacher

Magnets must be handled carefully to preserve their full magnetism. They should not be dropped or heated. U-magnets and horseshoe magnets are often supplied with a "keeper," a bar that is kept across the ends of the magnet when it is not in use. Bar magnets should be kept in pairs with the opposite poles in contact.

Pure nickel and pure cobalt are magnetic materials that can be used as magnets. In an alloy (mixture of metals) with aluminum, they make a very strong magnet.

The teacher should have a collection of magnets for the children to experiment with. Several bar magnets (both large and small ones), a horseshoe magnet, a U-magnet, a lodestone, and an alnico magnet are desirable. Often members of the class can bring magnets to school. Magnets may also be bought from a scientific supply company. (See page 95 of the *Guidebook*.)

Procedure

Have the children examine the different kinds of magnets as well as a lodestone and then read page 140. They may find other stories about the finding of lodestone in reference books such as elementary encyclopedias. The pupils may also wish to find out what kind of mineral lodestone is, where it is found, etc.

What kinds of things will a magnet pick up? (Pages 141-143)

Concepts

1. Magnets attract iron and steel.
2. Materials that can be picked up by a magnet are called *magnetic materials*.

3. Materials that cannot be picked up by a magnet are called *non-magnetic* materials.

4. The pull that a magnet has is called its *force*.

5. The force of a magnet can act at a distance from the magnet to pull things to it.

Experiments

Page 141: To find out what kinds of things a magnet will pick up.

Materials: Magnet, tacks, nails, needles, pins, copper penny, brass key, rubber band, eraser, pen points, paper clips, scraps of paper, bits of cardboard, pieces of iron, steel, wood, and chalk, sand, glass object, silver dime, iron filings.

Page 143: To find out from how far a magnet can attract a piece of iron.

Materials: Magnet, iron nail, ruler.

Information for the teacher

Possibly not all pins will be attracted by a magnet. Some are made of brass, which is non-magnetic. They are coated with another metal and look like pins made of steel.

Procedure

The first paragraph on page 141 should be read to furnish a purpose for doing the experiment to find out what kinds of things a magnet will pick up. Stress the necessity of following directions carefully, as brought out in the second paragraph on page 141. Then after the children have done the experiment and read pages 141 and 142, suggest that they read this first paragraph again to see whether it is true. Then have the pupils do the experiment on page 143.

Questions (Page 143)

1. So that you will not make mistakes and get the wrong answer.

2. Try to pick it up with a magnet. If the magnet picks it up, it is magnetic; if the magnet does not pick it up, it is non-magnetic.

3. Because it can pull things toward it. It can make things move.

4. Magnetic materials, such as iron, steel, nickel, cobalt.

5. No. The experiment with the magnet and the nail showed that the magnet could attract the nail even if it was not touching the nail.

What kinds of materials will the force of a magnet pass through? (Pages 143-144)

Concept

The force of a magnet will pass through many materials.

Experiment

Page 143: To show that the force of a magnet can act through materials.

Materials: Magnet, piece of window glass, books, iron nails.

Procedure

Have the pupils read the first two paragraphs on page 143 and then do the experiment. They can check their results by reading page 144. Encourage the children to think up and try experiments to find out whether the force of a magnet will go through paper, cloth, cardboard, thin wood, and other materials that they may suggest. There are many things they might do, such as completely wrap a nail in cloth or paper and then try to pick it up with a magnet.

What are the poles of a magnet? (Pages 144-146)

Concepts

1. The force of a magnet is strongest near its ends.

2. The ends of the magnet where the force is strongest are called the poles.

3. Every magnet has two poles, a north pole and a south pole.

4. A freely swinging magnet will point north and south.

5. The north pole points toward the north and the south pole toward the south.

Experiments

Page 144: To find out what part of a magnet has the most force.

Materials: Bar magnet, iron tacks, steel paper clips.

Page 145: To find out what part of a magnet has the most force.

Materials: Bar magnet, horseshoe magnet, U-magnet, iron filings.

Pages 145-146: To find out why the poles of a magnet are called north and south.

Materials: Bar magnet with poles marked N and S, string, wooden stand.

Procedure

Have the pupils do the experiments on page 144 and the first paragraph on page 145. After discussing the results and their conclusions, they should read the second paragraph on page 145. Next, have them do the experiment described in the last paragraph on the same page and the first on page 146. The concluding paragraph should then be read to check their findings.

If pupils have difficulty in answering question 3 at the bottom of page 146, ask them to plan and carry out an experiment to help find the answer.

Questions (Page 146)

1. The X's should be near the ends of the magnets.
2. Near the ends. At the places where the force is strongest.
3. Any magnetic materials that might be near would attract the hanging magnet and it would not be able to swing freely and so to turn to the north.

How do magnets act toward each other? (Pages 147-149)

Concepts

1. Two poles of the same kind are called *like* poles; poles of different kinds are called *unlike* poles.
2. Like poles of magnets repel each other.
3. Unlike poles of magnets attract each other.
4. A magnet whose poles are known can be used to find the poles of a magnet on which they are not marked.

Experiments

Pages 147-148: To find out how magnets act toward each other.

Materials: Two bar magnets with their poles marked N and S, two U-magnets, two horseshoe magnets, string, wooden stand.

Page 148: To find out the poles of a magnet that is not marked.

Materials: Bar magnet marked N and S, U-magnet that is unmarked.

Information for the teacher

Magnets obtained from supply houses are usually marked. On some magnets, only one pole is marked. This is usually the north pole, which is marked with N or sometimes +. If only one marked magnet is at hand for the first experiment, mark the second before starting the experiment.

Procedure

If a magnetic toy boat was used to introduce the unit, have a pupil put the boat in a pan of water and again show how the boat can be moved. Then have the children read the first paragraph on page 147. They are now ready to do the experiment, which is in two parts. The first part (page 147) deals with the repulsion of like poles, and the second part (page 148) deals with the attraction of unlike poles. Pupils should do the first part and give their own explanations before reading the explanation in the next two paragraphs. The findings can be written on the board somewhat as follows:

N pole pushed away another N pole.
S pole pushed away another S pole.

Now have the children read and discuss the explanation in the next two paragraphs. Then ask them what conclusion they can add to the findings written on the board. This conclusion should be written as follows:

Like poles of magnets repel each other.

Before the pupils do the second part of the experiment, ask them what they think will happen if the N pole is brought near the S pole or vice versa. Write the predictions on the board and then have the pupils do the experiment to check the predictions. As in the first part of the experiment, the findings can be written on the board:

N and S poles pulled toward each other.

Then the children should read the next three paragraphs and add the conclusion:

Unlike poles of magnets attract each other.

The pupils should verify the rules that tell how magnets act by doing the experiment in the next paragraph. They should see that the rules apply to different shapes of magnets. The experiment shows how the rules may be used to find the N and S poles of an unmarked magnet. After the pupils have done the experiment, they should read the concluding paragraph and answer the question in the last sentence. They can verify their answer by using the U-magnet to find the N and S poles of another unmarked magnet.

Questions (Page 149)

1. Like poles repel each other; unlike poles attract each other.
2. Yes. Every magnet has two poles, one N and one S. The unmarked pole will be south if the marked pole is N. You will then know both poles of one magnet. By seeing which ends of the unmarked magnet are attracted or repelled by the N and S poles of the known magnet, you can label the unmarked one.
3. No. If it were a magnet, one end would be an N pole and repel the N pole of the magnet.
4. Yes. It shows that it has two different poles, an S pole that is repelled by the S pole of the magnet and an N pole that is attracted by it.
5. The bar magnet will be attracted to the N pole of the other magnet, as any piece of magnetic material would be.

Why will a magnet point toward the north and the south? (Pages 149-150)

Concepts

1. The earth acts like a huge magnet.
2. The earth has two poles, the north magnetic pole and the south magnetic pole.
3. The north magnetic pole attracts the north-pointing pole of a magnet; the south magnetic pole attracts the south-pointing pole.

Information for the teacher

The earth's north magnetic pole is actually an S pole when the earth is considered as a magnet. This is known to be true because it attracts the N pole of a hanging magnet. Conversely, the earth's south magnetic pole is actually an N pole when the earth is considered as a magnet.

Procedure

While the class is studying this problem, have a marked bar magnet hanging from a wooden stand. The pupils can observe this as they discuss the text. The three important things they have learned about magnets should be written on the board. After the children have read and discussed page 149, a fourth thing should be added to the list:

The earth itself acts like a huge magnet.

Then have the pupils read to the end of the problem. At this point, pupils may ask either or both of the following questions:

1. Why does the N pole of a hanging magnet point toward the earth's north magnetic pole? Two N poles should repel each other.
2. Are the earth's magnetic poles at the North and South Poles? (In other words, are the magnetic poles the same as the geographic poles at the ends of the earth's axis?)

If the first question arises, ask the class: "If the N pole of a hanging magnet points toward the north, what kind of pole must the earth's north magnetic pole be?" (S pole.) "Why?" (Unlike poles attract each other.) But if the question does not arise, do not raise it. Unless the pupils want to know the answer, the information may only confuse them at this grade level. If the second question is asked, answer "No" and tell the pupils that they will learn more about it later in the unit (pages 153-154).

How can you make a compass? (Pages 150-152)

Concepts

1. A compass is used to tell direction on the earth.
2. A magnetic material can itself be made into a magnet by rubbing it on a magnet.

Experiment

PAGE 151: To make a compass.

MATERIALS: Marked magnet, steel needle, flat piece of cork, knife, glass or china dish, water.

Procedure

An inexpensive compass, such as the one pictured on page 152, should be available for the pupils to examine and use. Boys, especially Cub Scouts, may have compasses that they can bring to school. Have the pupils read to the last paragraph on page 151 and then make a compass like the one described in the text. The directions should be carefully followed. Be sure that the children do not rub the needle back and forth on one pole of the magnet.

After the compass has been made, the pupils should read and discuss the rest of the problem. Have the children verify their answer to question 5 by bringing a magnet near a compass.

Questions (Page 152)

1. So that it will be sure to show the directions accurately.
2. Describe the activity on page 151.
3. Sailors, explorers, hunters, trappers, airplane pilots, etc.
4. It can be used to find directions when the sky is cloudy or dark so that you could not use the sun or stars to help you.
5. The needle of the compass will move.

How can you use a compass? (Pages 153-154)

Concept

The needle of a compass does not point exactly north because the geographic poles and magnetic poles are not in the same places.

Experiment

PAGE 153: To find directions with a compass.

MATERIAL: Compass with colored needle.

Information for the teacher

The geographic North Pole is often spoken of as *true north*. Because of the difference in the positions of the magnetic pole and the geographic pole, the compass needle will not point directly north in most places. Many maps are made to show this difference between true north and magnetic north. This difference is called the *magnetic declination*. There is a curving line (the agonic line) that runs through both poles. This line is marked "No variation." Only on this line does the compass point true north. Strangely enough, the magnetic poles of the earth slowly change their positions. The constant moving of the magnetic poles makes it necessary for governments to make new magnetic maps of the earth from time to time. An almanac such as the *World Almanac* will tell what the variation is in different parts of the United States. Also see the map on page 254, *Science Problems, Book One*, or page 667, *Everyday Problems in Science*.

Procedure

By reading the directions on page 153, the children can easily learn to use a compass. It will help them to find out where north, south, east, and west are if they carry out the directions given in the second column of page 153.

The last paragraph explains that the geographic poles and the magnetic poles are not in the same place and that the compass needle points toward the magnetic poles. Therefore, a compass needle does not usually point to true north. It is neither necessary nor desirable to go further into this subject for children at this grade level.

Questions (Page 154)

1. Answers will include: used to find directions; needle is a magnet with an N and an S pole; the N pole is usually marked in some way; does not point exactly to the geographic North Pole in most places on the earth.
2. At the geographic poles.

Questions to answer (Pages 154-155)

1. It would hold the tack for you.
2. No. Magnets will not attract silver and gold, which are non-magnetic materials.
3. Consult an almanac for the variation in your locality. Knowing this would help you find out where north is or whether you should turn a little east or a little west to find north.
4. Jimmy. He did not jump to conclusions after one observation. He tried more than one experiment before he drew conclusions. Jimmy.

Things to do (Page 155)

1. True: (*a*), (*b*), (*c*), (*d*).
2. The force of a magnet will not pass through iron and steel.
3. The magnet that moves the needle more vigorously is the stronger.

4-5. The magnet should be strong and the objects light.

6. An electromagnet consists of a coil of wire wound around an iron core. It acts as a magnet only when a current flows through the wire. Consult a high-school general science book or one of the elementary encyclopedias. Electromagnets are studied in the unit on "Electric Current" in *Discovering Our World, Book Three.*

UNIT 7. *How Can You Keep Well?*

Purpose and scope

One purpose of this unit is to provide pupils with a basis for an intelligent, coöperative attitude toward the various school activities devoted to health and safety. Pupils should realize the importance of the school nurse, the school doctor, and the safety patrol. Another purpose is to develop in the children greater attention to their own health and safety.

The emphasis in the unit is on the positive side. It helps the children know the things that are good for them. It tells the boys and girls why these things are good for them. In so far as possible, children should understand the scientific reasons for developing good health and safety habits.

This unit gives an overview of good health practices and the reasons underlying them. A more detailed treatment of these practices will be found in *Discovering Our World, Book Two,* Unit 7, and *Book Three,* Unit 4. Additional safety information is provided at appropriate places throughout the series, such as *Book Two,* Units 3 and 6, *Book Three,* Units 1, 5, and 6.

Science background

Discovering Our World, Book One: Unit 2, Why Do All Living Things Need Air and Water? Unit 3, How Does Your Body Work?

General concepts

1. Signs, or symptoms, show when your body is not running well.
2. Proper care of your body helps keep it healthy.
3. Eating the proper foods is necessary for having a healthy body.

4. Proper amounts of exercise and rest are important for good health.

5. Clothes that are suitable for the weather and that fit properly are aids to good health.

6. Many diseases are caused by germs that get inside your body.

7. Many people are injured by accidents that could easily be prevented if people learned to work and play safely.

Introducing the unit (Page 157)

If several children have been absent from school because of illness and have missed some interesting school activity, this will furnish an excellent approach to the unit. The picture on page 156 of boys on a hike should arouse an interesting discussion. Have the pupils read on page 156 what they will learn in the study of this unit and then discuss the introduction on page 157.

How do you feel when you are sick? (Pages 158-160)

Concepts

1. Signs, or symptoms, show when your body is not running well.

2. Chills, fever, headache, sore throat, etc., are symptoms.

3. The sooner the doctor learns the symptoms, the sooner he can help your body get well.

Information for the teacher

Pictures. Page 158. The doctor is taking the child's pulse.

Page 159. The teacher is using the Betts Telebinocular, which has a battery of cards for the stereoscope and tests for many visual defects.

Text. Page 159. The rate of the pulse decreases from birth to adolescence. At birth, it is about 130 a minute and in an adult, about 70 a minute. However, this number may vary between 60 and 75 in people who are perfectly healthy. In animals the pulse rate is much higher in small ones than in large ones. For example, a canary bird's heart beats at a rate of 1000 a minute, while an elephant has a pulse rate of only 25.

Procedure

Let the children tell about times when they were sick, how terrible they felt, how bad the medicine tasted, etc. This should make them realize that they would much rather be well. Keeping well, therefore, becomes important to them.

Have the pupils read and discuss pages 158-160. Be sure the children understand and can pronounce the word *symptoms.* If possible, have the school doctor or school nurse talk to the class, as suggested in *Things to Do*, page 181, No. 5.

Questions (Page 160)

1. A doctor can help you get well more quickly.

2. It helps him find out what is wrong with you and how to cure it.

3. A sign that helps the doctor find out what is wrong. Cold symptoms: headache, chills, fever, sore throat, sneezing, coughing, etc.

4. No. Unless you have been told by a doctor what to take, it is not wise to buy advertised medicines for symptoms if you do not know what is causing these symptoms. Many diseases have similar or the same symptoms, and you may cause a more serious illness by taking the wrong medicine.

5. Because we may not always be aware of sickness in slight forms. Even in the absence of illness, a doctor can help you keep well.

How can you help keep your body well? (Pages 160-165)

Concepts

1. It is important not to overwork your heart.

2. Developing good posture helps keep your lungs healthy.

3. Eating properly, brushing your teeth correctly, and seeing the dentist regularly keeps your teeth healthy.

4. There are correct ways of caring for the ears and eyes.

5. Cleanliness and proper care of the skin are important in keeping well.

6. Your body will work better if you are happy and unworried.

Information for the teacher

Charts, pamphlets, and other supplementary material related to this problem and those following can be obtained at small cost from the following organizations:

American Dental Association. 22 E. Superior St., Chicago 11, Ill. Write for the list of Dental Health Educational Material. Charts, pamphlets, slides, etc.

American Medical Association. 535 N. Dearborn St., Chicago 10, Ill. Write for list of available pamphlets.

Association for Childhood Education. 1201 16th St., N.W., Washington 6, D.C. *Healthful Living for Children* and other pamphlets.

Association for Family Living. 209 S. State St., Chicago 4, Ill.

Child Study Association of America. 221 W. 57th St., New York 19, N.Y.

Procedure

As the pupils are studying this problem, have them make a list of the ways to keep well. This list should be somewhat as follows:

1. Don't overwork your heart by exercising too hard or too long.
2. Breathe deeply.
3. Sit up straight and stand up straight.
4. Brush your teeth each morning and evening.
5. Drink plenty of milk and eat fresh fruits and vegetables.
6. Take proper care of your ears and eyes.
7. Take a warm bath or shower at least twice a week.
8. Take proper care of cuts and burns.
9. Be happy and unworried.
10. Start the good habit of keeping well.

The list can be written on the board or made into a wall chart. It should be kept before the class during the study of this unit. From time to time, pupils may make additions to the list. For other activities in connection with this problem, see *Things to Do*, page 180, Nos. 3 and 4.

Questions (Page 165)

1. Rules will vary but should include the items mentioned in *Procedure*.

2. *Heart* pumps the blood that carries food and oxygen to all parts of your body. *Lungs* get the oxygen that you need into your blood. *Ears* may be injured, causing deafness. *Eyes* may be strained or injured, causing poor sight. *Teeth* grind and prepare food for your body, and must be taken care of so that they will last a long time. *Skin* keeps germs from getting into your body, and must be kept clean and healthy.

3. Germs may be forced from your nose up into your ears.

4. By having them checked by a doctor or dentist.

5. Because it allows germs to get into your body through the skin.

How does food help you keep well? (Pages 166-168)

Concepts

1. Eating the proper foods is necessary for having a healthy body.

2. Your body needs fuel foods (or energy-giving foods), body-building foods, protective foods, and water.

3. Carefully planned meals will insure that your body gets enough of the necessary foods.

Information for the teacher

PICTURES. PAGES 166-167. The specific names for the different kinds of foods have not been given in this unit. The pictures show the different kinds of foods as follows:

1. Energy foods:

   Fats: butter, oil, fat meat, lard.

   Carbohydrates: starches (bread, oatmeal, potatoes); sugars (molasses, sugar).

2. Body-building foods:

Protein (chiefly): meat, eggs, fish, cheese, beans.

Protein and minerals: milk.

3. Protective foods:

Vitamins (chiefly): tomato juice, carrots, whole-wheat bread, butter, oranges, grapefruit, lettuce, celery, tomatoes.

Vitamins and minerals: milk.

PAGE 168. The pictures show well-balanced meals because there are portions of each kind of food represented in the selections.

TEXT. It is not necessary to go into detail about the different vitamins and what each one does. This information is given in *Discovering Our World, Book Two,* Unit 7. At this level it is sufficient to stress the importance of eating vitamin-giving foods and the fact that such a diet will supply sufficient vitamins under normal conditions.

The teacher must often use tact in discussing home food situations with the students. If she knows the general circumstances of her pupils, she can approach the subject without causing embarrassment because of special food customs or economic conditions.

A very helpful bulletin on the teaching of nutrition at the elementary level is published by the U.S. Office of Education: *Nutrition Education in the Elementary School.* Nutrition Education Series Pamphlet No. 1. It can be obtained from the Superintendent of Documents, United States Government Printing Office, Washington 25, D.C., at a small cost.

Many helpful charts and pamphlets may be obtained from some of the large food companies. Advertisements in magazines such as *The Instructor* give suggestions for obtaining these.

Procedure

As the children are reading and discussing these pages, have them also study the pictures. These will help them remember the foods that are energy-giving, body-building, or protective.

Encourage pupils who bring their lunches to school to have the three kinds of foods in their lunches. For example, a cheese and lettuce sandwich made of whole-wheat bread spread with butter has the three kinds of food in it. Pupils who eat lunch at home or in the school cafeteria should be asked to tell what they would choose so as to get the three kinds of foods.

Additional activities are suggested in *Things to Do*, page 181, Nos. 6 and 7.

Questions (Page 168)

1. Because different kinds of foods are used for different things. Some food gives you pep and energy; some helps you grow; some helps keep you from getting sick; and some helps make blood and other liquids in your body.
2. Milk helps build bones and teeth.
3. No. You may not need the extra vitamins, and you may also take the wrong ones.
4. By knowing which foods your body needs and choosing some of each of those foods.
5. Answers will vary. Lists should include each of the three kinds of foods because the body needs some of each kind.
6. Eating between meals may spoil your appetite, and then you will not eat the foods your body needs.

Why do you need exercise and rest? (Pages 169-170)

Concept

Proper amounts of exercise and rest are important for good health.

Procedure

As the pupils are studying these pages, stress the importance of getting the proper amount of exercise and rest. Children are likely to get too much exercise and too little rest. Most children do not want to go to bed early. But after reading about the purpose of rest, they should realize the importance of getting enough sleep. If a child goes to bed at an early hour for several months, he will soon get the habit. Have the children figure out what time they need to go to bed to get eleven hours' sleep if they get up at 7:00, 7:30, 8:00, etc.

Questions (Page 170)

1. Rules listed in text, pages 169 and 170.
2. Exercise and rest help you keep well. Exercise makes your muscles strong and makes you breathe deeply. Rest gives your body time to repair the parts that are worn out during the day.

How can the right clothes help you keep healthy? (Pages 170-171)

Concept

Clothes that are suitable for the weather and that fit properly are important for good health.

Procedure

Have the pupils read and discuss the text down to the last paragraph that begins on page 170. Be sure that they understand the reasons for wearing suitable clothing. Urge them to wear such clothing not only to school but at all other times. They are more likely to do so after they understand the reasons. Now have the pupils read to the end of the problem and look at the pictures on page 171.

Questions (Page 171)

1. Your coat keeps the heat of your body from getting away.
2. In winter, you should wear clothes that will keep the heat from getting away from your body and keep you warm. In summer, you should wear clothes that will let the heat get away and keep you cool. In wet weather, you should wear clothes that keep your body dry because heat gets away easily through wet clothes.
3. Answers individual.

How can you keep from catching diseases? (Pages 172-174)

Concepts

1. Many diseases are caused by germs that get inside your body.
2. Germs may get into your body in several different ways.
3. There are many ways of preventing germs from getting into your body.

Information for the teacher

PICTURES. PAGE 172. Keeping cows and barns clean so that the milk will be clean involves keeping the barn scrubbed out, washing the cows, using sterile milk pails with covers, using clean food, keeping clean straw on the floor, having milkers wear clean clothes and keep their hands clean when milking, etc.

PAGE 173. Taking a bite from a piece of food that is being eaten by another child is one way of getting disease germs.

TEXT. Pasteurization means heating the milk to 144° Fahrenheit and keeping it at this temperature for 30 minutes. Home pasteurization is not difficult. It should be encouraged in communities where commercially pasteurized milk is not available.

Public drinking cups are still to be found in some places. Stress the necessity for avoiding use of them.

Procedure

As this problem is being studied, the class should list all the ways that the text mentions to prevent germs from getting into the body. These ways should be written on the blackboard and referred to from time to time. The list should be somewhat as follows:

1. Keep cuts and breaks in the skin clean.
2. Keep dirty fingers out of your mouth.
3. Eat and drink only clean food and water.
4. Fruits and vegetables must be carefully washed before they are eaten.
5. Food should be kept covered so flies cannot get at it.
6. Buy food only from stores that keep food clean.
7. Drink only clean milk.
8. It is safest to drink pasteurized milk.
9. Be sure the water that you drink is safe.
10. Do not drink out of cups left in public places.
11. When using a drinking fountain, do not touch it with your mouth.

12. Stay away from school or other people when you have a cold.

13. Cover your nose and mouth with a handkerchief when you sneeze or cough.

For additional activities, see *Things to Do*, page 180, No. 2 and page 181, No. 8.

Questions (Page 174)

1. Through cuts and breaks in your skin, through food and water, by putting your fingers in your mouth, through your nose when you breathe. Keep your skin clean and healthy; food and water should be clean; milk should be pasteurized; use your own cup or glass; keep your fingers out of your mouth; etc.

2. Milk should be pasteurized, and the water should be tested. Germs can easily get into your body when you drink unclean water or milk.

3. Your fingers touch many things that have germs on them. If you put your fingers into your mouth, the germs get into your body.

4. *Germs* are tiny plants or animals that can make you sick when they get inside your body and grow there. They can get into your body in many ways. We must try to prevent germs from entering the body. *Coughing* spreads germs very quickly. If you must cough, be sure to cover your nose and mouth with a handkerchief. *Pasteurizing* is a way of heating milk enough to kill any germs that may be in it.

How can you keep from having accidents? (Pages 174-179)

Concept

Many people are injured by accidents that could easily be prevented if people learned to work and play safely.

Information for the teacher

Pictures. Pages 175 and 179. These show situations that could cause accidents.

Pages 176, 177, and 178. These pictures show proper safety methods.

Text. The National Safety Council, 20 N. Wacker Drive, Chicago 6, Ill., has pamphlets and charts on various aspects of safety. A list of available materials will be sent to teachers upon request.

Procedure

Needless to say, the importance of preventing accidents cannot be stressed too much. The purpose of this problem is to make pupils safety conscious and resolved to do everything possible to prevent accidents to themselves and others. If pupils do careless or dangerous things, discuss these things with them and show them why their behavior is likely to cause an accident. When accidents happen in the school or community, discuss how they might have been prevented. See also *Things to Do*, page 181, Nos. 9 and 10.

As the pupils are studying these pages, have them list the safety rules given in the text and add any others that they think are important. The list should be put on the board or made into a wall chart so that it will be a constant reminder to the class.

Questions (Page 179)

1. The pictures on pages 176, 177, and 178 show ways of acting safely. Accidents of cars hitting children can be prevented by having safety patrol boys; riding bicycles near the curb on the right side of the street will help prevent cars from running into them; letting motorists know that certain hills are being used for coasting and coasting only on those hills will prevent many accidents.

2. *Swimming:* Wait two hours after eating before going swimming; do not go alone; stay in shallow water if you are not a good swimmer.

Walking to school: If you walk on the highway, walk on the left side; stop and look both ways at crossings.

Skating: Do not skate in the street, watch for other people.

Riding a bicycle: Ride your bicycle on the right side of the street near the curb; have a bell and lights for riding at night.

Playground: Be careful of other people on the playground.

Coasting: Coast only on a hill that is safe from cars.

3. Lists may include: Never leave things where people may fall over them. Handle scissors and knives carefully. Never play with matches. Do not touch medicines or bottles in the medicine cabinet.

Questions to answer (Page 180)

1. Cut fingers, broken teeth, infection, cut foot. Safety rules might be: Do not play with machines that may hurt you. Do not shove or push other children to "show off." Watch where you step. Do not leave boards with nails in them where they may be stepped on. Do not use hatchets or any sharp tools carelessly.

2. Each person should have his own personal things and use only his own because germs are easily carried on these things. They should be kept clean at all times.

3. Answers will vary.

4. List may include: overexercise (may harm your heart); have poor posture (you cannot breathe properly); read in poor light (causes eyestrain); put sharp objects in your ears (may harm your eardrums); neglect to keep your skin clean (germs may enter your body more easily).

5. Answers will vary.

Things to do (Pages 180-181)

1. Answers will vary but should include this idea: If you understand how your body may become sick or injured, you can help keep yourself well.

2. Individual or group activity.

3-4. Individual activity. Pictures should be mounted on cardboard for display.

5. The teacher should tell the doctor or nurse what the class is studying so that these aspects of health and safety can be stressed.

6-7. Individual activity.

8. Refrigeration and pasteurizing are two ways to keep foods fresh and clean.

9. Individual activity.

10. Local automobile clubs or the police department will usually be glad to help in organizing a Safety Patrol.

UNIT 8. *How Do Animals and Plants Grow?*

Purpose and scope

The first unit of this book brought out the fact that growth is a characteristic of all living things. To understand this more thoroughly, children need to know about some of the changes that take place as living things grow. Another characteristic of living things is that they need food. Since growth depends on food, this unit provides an opportunity for further development of these basic understandings.

Children are aware of the difference in size of young and mature animals. Through the study of this unit, pupils should become conscious of the various changes in structure that take place in the process of growth. They should learn that growing plants and animals take in materials from outside and change these into the materials of which they are made. Food is essential to the growth of all living things.

The situations described in this unit can be duplicated in the classroom. It is essential that many of the basic understandings be learned through actual observation of live plants and animals. The unit provides a valuable background for later units of the series, such as *Discovering Our World, Book Two,* Units 8 and 9, and *Book Three,* Unit 9.

Science background

Look and Learn: Unit 1, Animals; Unit 4, Outdoors

All Around Us: Unit 1, Animals; Unit 4, Plants

How Do We Know?: Unit 1, Animals; Unit 3, Plants

Discovering Our World, Book One: Unit 1, How Are the Things of the World Put into Groups? Unit 2, Why Do All Living Things Need Air and Water?

General concepts

1. All living things change as they grow.
2. The material added during growth is made by living things from the food that they use.
3. Insects and amphibians go through distinct changes as they grow.
4. Mammals, birds, reptiles, and fish change in certain ways as they grow.
5. A seed is a baby plant with food that starts it growing and a covering that protects it.
6. Stems and roots increase in length by growing at their ends.
7. Some plants get thicker by adding layers of wood; some get thicker by growing all through the inside.
8. It takes a long time for trees to grow big.
9. Since trees are important to us in many ways, we must conserve our trees and use them wisely.
10. Roots, stems, and leaves of plants grow in certain directions.

Introducing the unit (Page 183)

Information for the teacher

PICTURES. PAGE 182. This picture was taken at the Trailside Museum in Oak Park, Illinois. The boy is one of the "junior curators." He is feeding worms to the young robins. There are a pair of owls and a mourning dove in the cage, too.

PAGE 183. Mountain lion and young. The spots disappear from the cubs as they grow older. This animal ranges from Canada to southern South America. In different parts of its range, it is variously known as the puma, the cougar, or the panther.

Procedure

An interesting way to begin this unit is to ask one of the pupils to bring a photograph of himself as a baby, but not to show it or tell the other children. Hold this photograph up before the class and ask the pupils if they know who it is. Then have the class compare the child as he is now with the picture taken when he was a baby. This shows that the child has changed as he has grown.

Then let the pupils read page 183. Stress the difference in the way the snowman and a child grows. If they do not readily recall comparing a snowman with a real man to see the difference between living things and non-living things, have them read the first two paragraphs on page 15. Also have them list the five ways in which all living things are alike as given on page 12. One of these ways is that living things can grow. Another is that living things need food.

What happens when animals grow? (Pages 184-185)

Concepts

All living things change as they grow.

a) They get larger.

b) They may add new parts.

c) They may change from one form to another.

Information for the teacher

PICTURES. PAGE 184. The blacksnake, which grows to a length of six feet, is found in the eastern United States. A bluish-green variety of this snake, found in the Central States, is known as the Blue Racer.

PAGE 185. Phoebe and young. Eastern and central United States.

Procedure

As the pupils are reading pages 184 and 185, encourage them to tell about experiences with anything that involved growth in animals, such as finding a snake skin, tadpoles, growing pets, chicks, etc. Have the children make many comparisons of young and mature animals such as children with their parents; chick with hen; baby elephant with mother elephant; etc. In each comparison, have the class note the addition of new parts as the animals grow older. Children get more teeth, a chick gets a comb and feathers, an elephant gets tusks, etc. Also bring out the fact that some animals change so much as they grow older that they look entirely different from the way they were when young, for example, a tadpole and a frog. For additional activities suitable for this problem, see *Things to Do*, page 214, Nos. 4 and 5.

Questions (Page 185)

1. Answers may include: (*a*) Cats, dogs, horses, etc., get bigger when they grow. Their legs get longer, bodies fuller, etc. (*b*) Frogs add legs; birds add feathers, etc. (*c*) Frogs, butterflies, moths, mosquitoes all look like different kinds of living things at different times.
2. Grown larger, have teeth, more hair, etc.

How do insects grow? (Pages 186-190)

Concepts

Insects go through distinct changes in form as they grow.

a) Some insects have four stages in their life.

b) Some insects have only three stages in their life.

Observations

PAGES 186-187: To observe the changes in a butterfly.

MATERIALS: Caterpillar or chrysalis of a butterfly (Monarch if possible), box or cage, food. (See page 90 of the *Guidebook*.)

PAGE 188: To observe the changes in a moth.

MATERIALS: Caterpillar or cocoon of a moth (Cecropia if possible), box or cage, food.

Information for the teacher

PICTURES. PAGES 186-187. Caterpillar, chrysalis, and adult of the Monarch butterfly, also known as the milkweed butterfly because the caterpillar feeds on milkweed. Caterpillars found in September will make a chrysalis, emerge, and if liberated, will migrate south. Large numbers gather together and migrate south in the fall. A few of these return north in the spring.

PAGES 188-189. Eggs, caterpillar, cocoon, and adult of the Cecropia moth. This is one of the silkworm moths, and it is the largest species. It may have a wingspread as great as six inches. The males have bushy antennae and the females slender ones. The caterpillars eat the leaves of various trees, including walnut and hickory.

PAGE 190. *Top*, eggs, young grasshopper (or nymph), adult. Grasshoppers and crickets do not go through a larval stage. This is known as *incomplete* metamorphosis. The nymphs differ from the adults in their large heads and lack of wings. The grasshopper lays her eggs in cases about an inch below ground. She lays the eggs in the fall and they hatch in the spring. *Bottom*, eggs, young cricket, adult cricket. The eggs of the cricket are laid individually in the ground.

PAGE 191. This picture illustrates the differences between moths and butterflies.

TEXT. The four stages that an insect may go through in its life cycle are egg, larva (caterpillar), pupa (cocoon or chrysalis), adult. Changing from one form to another in this way is known as *metamorphosis*. To keep the technical vocabulary at a minimum, the terms larva, pupa, and metamorphosis are not used in the text. However, the term larva may be taught or the word caterpillar may be used for this stage. *Worm* should not be used for larva. This is a common but incorrect use, as a true worm never becomes an insect. An earthworm is a true worm.

Tomato worms finally form one of the kinds of the Sphinx moth. Carrot worms change into one of the swallowtail butterflies. Larvae may be difficult to identify. Identifications are more frequently made when the adults emerge from the cocoons or chrysalises. See Bibliography, page 85 of the *Guidebook*, for books that will help in identification.

When collecting cocoons, the children may find it difficult to tell a live cocoon from a dead one. Live cocoons are usually heavier and thump when they are shaken. Dead cocoons are usually light and rattle when they are shaken. Small holes in the cocoons are usually an indication that the pupa has been eaten by a parasite.

If cocoons are kept indoors during the winter, they should be sprinkled with water two or three times each month. Cocoons may be put into a box and kept outdoors during the winter. Bring the box indoors in March or April. If no cocoons are collected, the complete life history of moths may be observed by growing silk worms. Eggs may be obtained from biological supply houses at low cost. See page 95 of the *Guidebook*.

Procedure

Watching insects grow through their different stages is one of the most exciting things that children can do. Have the pupils read the text and carry on the activities as the class in the book did. The pupils should have collected many different kinds of caterpillars. Cages should be made for them and food provided. The caterpillars (larvae) eat the kind of leaves on which they were found. Urge children to notice this when catching them so that fresh leaves may be brought daily. Too many caterpillars should not be put together in one box. The class should take the responsibility of caring for all the materials in the classroom. A good plan is to choose several committees, each having its own duty to perform.

Insect eggs, cocoons, and chrysalises should also be brought to class. If cocoons or chrysalises were collected in the fall, put them in insect cages in the spring where the children will be more likely to see the moth or butterfly emerge. In fact, the boys and girls will need to watch their insects carefully, or they will miss some of the interesting changes. Various groups should be assigned to check up hourly on the stages when something is likely to happen, such as a caterpillar molting its skin, spinning a cocoon or making a chrysalis, or emerging from it.

The class should also find eggs and larvae of ants and flies as well as of moths and butterflies to show that these insects have four stages in their life, namely egg, larva, pupa (cocoon or chrysalis), adult. Stress the fact that an adult insect does not grow any larger. A little fly with wings does not grow into a big fly.

Have the children draw pictures of the different growth stages of the insects that they observe. Color and label each picture. Different groups of children may each make a large chart showing the life story of an insect.

After the boys and girls have thoroughly learned the four stages through which many insects grow, they should then study the growth of grasshoppers and crickets, pages 189-190. In the spring, young grasshoppers and crickets are easily found. If these are put in a cage and provided with food daily, they can be observed to molt several times and become full-grown grasshoppers or crickets with wings.

Have the children make drawings of the growth stages of grasshoppers and crickets, namely, egg, young, adult. Large charts may be made by different groups of pupils.

Additional activities related to this problem will be found in *Things to Do*, page 214, Nos. 1, 2, 3, and 6.

Questions (Page 190)

1. Egg, caterpillar, chrysalis, butterfly.
2. Egg, small grasshopper or cricket without wings, adult insect with wings.
3. The skin does not grow. It gets too tight as the animal grows from the inside. After a caterpillar sheds its skin, it can grow larger.
4. Butterfly. It changes its whole appearance in various stages while a cat only grows larger.
5. Wings.

6. Chrysalis. Cocoon.
7. Housefly.

How do amphibians grow? (Pages 191-194)

Concepts

Amphibians go through distinct changes in form as they grow.

a) They are hatched from eggs in water and breathe through gills.

b) They develop lungs for breathing on land.

Observation

Pages 191-193: To observe the changes in frogs or toads as they grow.

Materials: Aquarium or large glass jar, frog eggs or toad eggs, tadpoles.

Information for the teacher

Pictures. Pages 192-193: Development of the leopard frog.

Page 194. Toads' eggs. There may be from 4000 to 7000 eggs in a string.

Text. Some tadpoles develop more rapidly than others, depending on the kind. Toad tadpoles develop more rapidly than frog tadpoles. The times for developing from eggs to adult of some toads and frogs are:

Common toad....	6-7	weeks
Leopard frog......	2-2½	months
Pickerel frog......	2-2½	months
Spring peeper.....	2-3	months
Green frog........	1	year
Bullfrog	2	years

When frog eggs are collected, they should be kept in water from the pond where they were found. The young growing tadpoles eat vegetable matter (pond scum, water weeds, etc.). Do not keep too many in one container. See page 91 of the *Guidebook* for information on keeping tadpoles and frogs in an aquarium.

The pupils may recall another amphibian, the salamander, from *Discovering Our World, Book One*, Unit 1. The development of these amphibians is similar in that the young have gills and the adults have lungs. The term *tadpoles* is, however, not used for the young of any amphibian other than those that lose their tails when they grow to adults, as the frogs and toads do. The young of the other types, such as salamanders, are referred to as larvae.

Procedure

Have the pupils read these pages and carry on the activities as the class in the book did. Get some tadpoles so that the children can see them grow larger and eventually change into frogs or toads. Or get some frog eggs or toad eggs and watch them hatch. Usually there is a boy who knows of a pond where he can get the eggs. Emphasize the change that takes place inside a tadpole's body. It breathes with gills in water. As it grows, it develops lungs for living on land. Recall that this is a characteristic of amphibians.

Questions (Page 194)

1. Get hind legs, get front legs, come out of the water, molt their skins.
2. One with front legs.
3. A toad tadpole.

How do other groups of animals grow? (Pages 194-196)

Concepts

Mammals, birds, reptiles, and fish change in certain ways as they grow.

a) Snakes molt their skins while they are growing.

b) Some young birds have no feathers, and others are covered with down.

c) Many mammals change the markings of their coats as they grow.

Information for the teacher

Magazines such as *Nature Magazine*, *Natural History Magazine*, *Canadian Nature*, etc., and books such as *Parade of the Animal Kingdom* will give much additional background material for this problem. See the Bibliography, page 85 of the *Guidebook*.

Procedure

Have the class recall the other groups of animals that they studied in the first unit of the text. These are mammals, birds, reptiles, and fish. Encourage the children to find pictures and tell of their own experiences to show how animals in these different groups grow. Then let the pupils read and discuss pages 194-196.

Questions (Page 196)

1. Insects, amphibians.
2. Fish grow larger; birds grow feathers and get larger; mammals grow larger, sometimes change their markings, grow fur, hair, etc.

How do plants with seeds begin to grow? (Pages 197-199)

Concepts

1. A seed is a baby plant with food that starts it growing and a covering that protects it.
2. The little plant goes through many changes as it begins to grow.
3. It takes different lengths of time for different seeds to grow.

Observations

Pages 197-198: To observe how a seed sprouts and how the plant changes as it grows.

Materials: Box of good soil about four inches deep, bean seeds, corn seeds, one dozen flat wooden sticks for plant labels.

Pages 197-198: To study the structure of a seed.

Materials: Bean seeds, corn seeds, magnifying glass.

Information for the teacher

Pictures. Page 197. This shows how the observation on pages 197-198 should be set up. Be sure that the box has good drainage. Select good seeds so that a high percentage will sprout.

Page 198. *Left*, bean seed. *Right*, corn seed. Corn and bean seeds are representative of the two large groups of flower-bearing seed plants. The embryo of a plant consists of an axis with one or two leaves, called *cotyledons*, and the parts that develop into the stem, roots, and true leaves of the mature plant. The plants that have seeds with one cotyledon are called *monocotyledons*. Corn represents this group, which also includes the other grains such as wheat, oats, etc., grasses, lilies, iris, palms, etc. The plants that have seeds with two cotyledons are called *dicotyledons*. In most plants of this group, the seed leaves are fleshy food-storage organs, and are easily recognized. Beans, peas, and most of the flowering plants belong to this group.

In the picture of the bean seed, the parts labeled "plant food" are the cotyledons. In the picture of the corn seed, the cotyledon is not so easily seen. It is the large outside leaf at the left on the embryo plant. In this kind of seed, the food for the embryo is stored in another structure.

If the children grow other types of dicot seeds, they may find that not all of them bring their cotyledons above ground when they sprout. Peas, for example, have the cotyledons underground when they grow. Pupils may wish to sprout different kinds of seeds so that they can watch them develop. The seeds can be sprouted on moist blotting paper.

Procedure

The pupils should read these pages and carry on the activities. Have them plant bean seeds and corn seeds as directed on page 197. This should be begun two weeks before the class is ready to study this problem. Also, about six weeks before the study of plant growth, have different children plant seeds of green beans, nasturtium, petunia, zinnia, and morning glory so that the plant cycle from seed to seed may be completed by the time this unit is completed. Have enough soaked beans and soaked corn so that each child may have one of each to examine. A magnifying glass will help in observing the structure of the seeds as shown in the picture on page 198.

Questions (Page 199)

1. To get plants of different ages so as to see how plants change as they grow.
2. The root.
3. They are getting smaller because the food inside is being used up.
4. It has dried up and dropped off.
5. It has been used up by the growing plant.

How do plants grow taller? (Pages 200-201)

Concept

The stems and branches of plants grow longer by growing at their ends.

Experiments and observations

Page 200: To find out how a plant grows taller.

Materials: Growing bean plant from the experiment on pages 197-198, waterproof black ink, pen, ruler.

Page 201: To observe how twigs and branches grow longer.

Materials: Twigs without leaves, such as the horse chestnut or the cottonwood poplar, which show the rings and scars most clearly and are most easily studied.

Information for the teacher

Pictures. Page 201. *Top,* bean plant used in the observation on page 200. *Bottom.* The rings on the branch are made by the scars left when the terminal bud scales fall off. There are also scars left by the leaves when they fall off. These are known as *leaf scars.* There are two leaf scars at the base of the terminal bud in the picture. The other marks along the stem are *lenticels,* or "breathing holes," in the bark. These allow oxygen to get into the cells of the stem under the bark.

Procedure

Have the pupils look at the pictures on page 200 and try to decide what they show. Then let them read the first paragraph and give their own explanations of why the horseshoe remained the same distance above the ground. Then the pupils should do the experiment as directed on page 200. Be sure that they make use of the picture at the top of the next page. Have them measure the distances between points 1 and 2 and points 2 and 3. They should observe that these distances do not increase as the plant grows taller.

If pupils have difficulty in understanding why the horseshoe stayed at the same height above the ground, use a pile of books to demonstrate what happens. Make a small pile with a book of a different color, such as red, on top. Then add more books, one by one, to the pile. Let the children observe that the red book stays in the same place as the pile grows taller.

Have the pupils read page 201 and examine twigs, using the picture at the bottom of the page. Let them find the bud at the end and also the rings that show each year's growth. Emphasize the fact that last year's growth is at the end. The pupils may wish to label each year's growth. See also *Things to Do,* page 214, Nos. 7, 8, 9, and 12.

Questions (Page 201)

1. By counting the spaces between the rings of rough bark around it. Each one shows a year's growth.
2. They grow taller by growing at the top. You can show this by marking the stems.
3. No. The tree grows from the ends of the branches.

How do the roots of plants grow longer? (Pages 202-204)

Concept

Roots grow longer by growing at their ends.

Experiment

Page 202: To find out how the roots of plants grow longer.

Materials: Bean or corn plants from experiment on pages 197-198, waterproof black ink, ruler, pen, box, moist sawdust.

Information for the teacher

PICTURE. PAGE 203. The increase in length in the intervals just back of the growing tip is brought about by the elongation of the cells in this region and not by the addition of new cells. The growth in length of the root is brought about by the addition of new cells in the growing region at the tip and also by the elongation of the cells just back of the tip. After these cells have elongated a certain amount, they do not further increase in length. Therefore, the intervals farthest from the tip do not increase in size.

Procedure

Have the pupils do the experiment on page 202, using the pictures. The experiment will require the teacher's help, since it must be done carefully. Caution the pupils to handle the plants carefully when they mark the roots and not to let the sawdust become dry. The plants should be marked as quickly as possible and then put in the moist sawdust.

If possible, have the class examine the roots of different weeds as suggested on page 203. Then the pupils should read to the end of the problem on page 204.

How do the stems of plants get thicker? (Pages 205-207)

Concepts

1. Some plants get thicker by adding layers of wood.
2. Some plants get thicker by growing all through the inside.
3. It takes a long time for trees to grow big.
4. Since trees are important to us in many ways, we must conserve our trees and use them wisely.

Observations

PAGE 205: To observe the growth rings in a tree trunk.

MATERIALS: Pieces of tree trunk or branches sawed to show the cross section.

PAGE 207: To see how a cornstalk gets thicker.

MATERIAL: Cornstalk.

Information for the teacher

PICTURES. PAGE 205. It is not always possible to determine the exact age of a tree by counting the rings. Sometimes the rings may be indistinct. Stress the fact that you can tell *about* how old the tree is. These rings are seen only in trees in the temperate zones. Tropical trees do not show them. Sometimes the rings may be broader or narrower than the average for a given tree. The broader rings may indicate years of more than average rainfall and the narrower ones, dry years. The tree on page 205 was about twenty-four years old.

PAGE 206. *Left*, a redwood grove near Bull Creek Flat, California. The trees are Sequoia Sempervirens. *Right*, the famous redwood, Wawona, a Sequoia Gigantea in Mariposa Grove, Yosemite National Park, California.

PAGE 207. The small groups of cells scattered throughout the stem in the corn plant are the bundles of conducting cells that carry the water from the roots up through the stem and the food down from the leaves to all parts of the plant. Other plants that grow this way are the grasses, palms, lilies, and other monocotyledons.

TEXT. For this problem, an excellent book for supplementary reading for elementary pupils is *Big Tree* by M.M. and Conrad Buff, New York: Viking, 1946. The historical references may not all be understood at this grade level, but it gives a dramatic picture of the ages and sizes of the big trees as well as of the forest life around them.

Procedure

Have the pupils read to the end of the first paragraph on page 206. Let them examine a cross section of a tree trunk or branch to see the growth rings, such as those shown on page 205. Also urge the children to look for growth rings in tree stumps.

Then the class should read to the second paragraph on page 207 and discuss the pictures on page 206. The importance of forest conservation should be stressed. See also *Things to Do*, page 214, No. 11.

The children should now examine the cross section of a cornstalk to observe the other way in which the stems of plants grow thicker. Have them compare the cross section of the cornstalk with that of the tree trunk, as suggested on page 207. They should see that the cornstalk has no growth rings but that it becomes thicker by growing all through the inside.

Questions (Page 207)

1. By adding layers just under their bark. By growing all through the inside.
2. By counting the dark layers or rings in the trunk.
3. It takes a long time for them to grow big; they provide shade, are homes for birds, keep the soil from being washed or blown away, etc.

In what directions do the parts of plants grow? (Pages 208-212)

Concepts

Roots, stems, and leaves of plants grow in certain directions.

a) Roots grow down, and stems grow up.
b) Roots grow toward water.
c) Stems and leaves grow toward light.

Experiments

PAGES 208-209: To see in what direction roots and stems grow.

MATERIALS: Glass, moist sawdust or sand, blotting paper, corn seeds.

PAGES 209-210: To show in what direction stems grow.

MATERIALS: Three small geranium plants in flower pots, two pieces of wire screen, wire, strong cord.

PAGES 210-211: To show that roots grow toward water.

MATERIALS: Small unpainted flower pot, rubber stopper to fit hole in pot, sealing wax or paraffin, two boxes of rich soil about two feet square, bean seeds.

PAGE 211: To show that stems grow toward the light.

MATERIALS: Small cardboard box about three inches deep, shallow dish, blotting paper, bean, radish, or grass seeds.

PAGES 211-212: To show that leaves turn toward the light.

MATERIAL: Small geranium or other house plant in a flower pot.

Information for the teacher

TEXT. Growing toward or away from a stimulus is known as a *tropism*. Growing toward or away from the earth (gravity is the stimulus) is *geotropism*; toward or away from water is *hydrotropism*; toward or away from light is *phototropism*. The tropisms are positive or negative depending on whether the plant parts grow toward or away from the stimulus. Thus roots show positive geotropism and negative phototropism, while stems show positive phototropism and negative geotropism. There are other stimuli, such as chemicals and touch, that induce tropisms; but the ones taught in this problem are the most obvious ones. Tropisms in plants are growth responses whose causes are too difficult to explain at this level. Some of the reactions of simple animals are also known as tropisms, but their mechanism differs from that of plant tropisms.

PICTURES. PAGE 208. The roots of the corn plants show positive geotropism. The stems show negative geotropism and positive phototropism. The bean plant shows the same tropisms.

PAGE 209. The stem of the geranium is showing negative geotropism and positive phototropism.

PAGE 210. The roots of the bean plants show positive hydrotropism.

PAGE 212. *Left.* The stems and leaves of the bean plants show positive phototropism. *Right.* The fern leaves are spread out in response to the light in such a way that each leaf receives the maximum amount of light available. This phenomenon is often seen in thick vines on a wall. The leaves are spread out so that each one receives light. This arrangement is known as a *mosaic* of leaves.

Procedure

The experiments in this problem require observations to be made over a period of time varying from a few days to several weeks. Therefore, the experiments should be started well in advance of actual study of the problem. Committees should be chosen to assemble the materials and perform each experiment. The text gives detailed directions for doing the experiments and making the observations.

Have the pupils read and discuss the first paragraph on page 208. Then ask the committee that performed the first experiment to exhibit the results and report its findings to the class. The report should include the purpose of the experiment, the materials and procedure used, and the results. The corn seeds will look like those in the picture at the left on page 208. The pupils should now read down to the end of the left-hand column on page 209 to check the report of the committee. Then ask the class to make a conclusion from the experiment and write this on the board:

The roots of plants grow down, and the stems grow up.

In a similar manner, proceed with the other experiments. Call for the report of the committee. Have the class check its findings by reading the text and then make a conclusion. For a culminating activity, see *Things to Do*, page 214, No. 10.

Questions (Page 212)

1. By turning the plant on its side or in different positions.
2. Roots grow down toward water that the plants need, while stems grow toward light that plants need.
3. Toward.
4. Toward.

Questions to answer (Page 213)

1. Eggs, larva, pupa, adult.

2-3. Group activity.

4. Reading, pictures, experimenting, observation.

5. Toads' eggs, mosquito eggs, and tadpoles may be found in ponds, stagnant pools, rain barrels, etc. Monarch butterfly eggs are usually found on the leaves of milkweed plants. Grasshopper eggs are found in gardens and fields just below ground.

6. *Like*: Plants and animals both grow larger and change their appearance. The seed part of a plant's life looks entirely different from the full-grown plant. Plants add different parts as they grow, as some animals do. *Different*: Plant parts grow longer by growing at the ends; animals grow all over.

7. After a seed is planted and watered, the seed begins to break apart. A root comes out and makes its way downward through the soil. Shortly after, a tiny stem starts up from the seed. The original seed is growing smaller during this process as the new plant is using up the food stored in the seed. The outer seed covering dries up and falls off. The seed finally disappears entirely, the root grows longer, the stem develops more leaves. Finally, there is an adult plant.

8. By knowing the structure of a seed, you know where the stem, root, leaves, and food for the baby plant come from.

9. **Animals.** *Mammals:* cat, dog, lion, deer, bear, mouse, rat, human. *Birds:* robin, bluejay, chicken, duck, Canada goose. *Reptiles:* snake. *Fish. Amphibians:* frog, toad. *Insects:* Monarch butterfly, Cecropia moth, bee, ant, fly, grasshopper, cricket. **Plants.** *With Flowers and Seeds:* corn, bean, lettuce, pumpkin, white oak, poplar, sugar beet, dandelion, burdock, plantain, chickweed, goldenrod, daisy, geranium, radish, grass.

Things to do (Page 214)

1. See suggestions for finding and keeping cocoons, page 77 of the *Guidebook*.

In addition to Cecropia, cocoons and larvae of the Promethea moth and the Polyphemus moth may be collected. These are also giant silkworm moths. The large larvae are found in the spring, but the cocoons are not found until late summer or fall. The Promethea moth spins its cocoon inside a leaf. It fastens the edges of the leaf together with a silk thread and spins the cocoon inside the leaf. These may be found hanging from a slender twig when the leaves are gone in the fall. The cocoon of Polyphemus is more like that of Cecropia but more egg-shaped and more compact than the large spindle-shaped cocoon of Cecropia.

2. See suggestions for keeping and feeding larvae, page 77 of the *Guidebook*.

3. An ant's nest can be examined outdoors or one can be brought into the classroom. Directions for making an observation ant's nest are given on page 91 of the *Guidebook*.

4. Individual or group activities.

5. If children keep some of their pets at school for several days, consult page 90 of the *Guidebook* for suggestions for care.

6. Young grasshoppers are found in the spring. They hatch from the eggs laid in the ground the previous fall.

7. A shallow box similar to a florist's "flat" is very satisfactory. Keep the sand moist. When the cuttings are made, be sure to have at least two joints, one near the top and the other near the bottom. Take most of the leaves off the cuttings.

8. A narcissus leaf grows longer but does not grow wider.

9. A geranium leaf grows in all parts of the leaf, so that it has the same shape but is larger.

10. Group or individual activity.

11. See magazine articles. Example: "Giant Trees of the World," *Nature Magazine*, November 1940.

12. Other vines besides ivy may be used.

Part Three BIBLIOGRAPHY

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For pupils and teachers

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For the teacher

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Part Four MATERIALS AND SOURCES

Care of Living Things in the Classroom

Animals

General suggestions. QUARTERS. Provide roomy and comfortable quarters for every animal—aquaria and terraria (see below) for land and water forms; cages of screen, hardware cloth, or other material for mammals, insects (see below), etc. The cage must be cleaned daily, or a diseased pet will result. *The cage should have a removable bottom for cleaning facilities and stationary containers for food and water.* Line cage with newspapers or other material that may be destroyed. Provide sleeping quarters such as straw or a comfortable box.

WATER. Provide with fresh water daily.

FEEDING. Feed daily. Most wild animals must be trained to eat in new living quarters. Patience is necessary. Try to imitate the living conditions of the animal as they were in its natural environment. Remove surplus food after animal has eaten. Provide plenty of food; the animal will not overfeed. There is no more pitiful spectacle than half-starved animals in a laboratory.

Delicate animals such as guinea pigs should be fed twice daily and at regular times. Early morning and late evenings are best. On Fridays provide enough to last over Sunday. Cold-blooded animals such as frogs, lizards, swifts, turtles, etc., do not require as much food as warm-blooded animals. One feeding a day is ample. A large feeding every other day is sufficient in most cases. In aquaria do not leave uneaten food to foul the water.

Vary diet to prevent weakness and disease. The following food list is suggested.

Snails: Lettuce leaves, aquatic plants, powdered meat, powdered cuttlefish bone.

Fishes: Prepared fish food, chopped beef, particles of earthworms.

Salamanders and lizards: Flies, earthworms, chopped beef, liver.

Frogs: Diet varies with kind of frog. Insects, fruit flies, roaches, earthworms, larvae, chopped beef, very small strips of liver, etc.

Turtles: Overripe fruit, lettuce, clover, carrots, strips of liver.

Snakes: Small frogs, mice, lizards, beef, liver, chicken scraps.

Rats and mice: Table scraps, cheese, wheat flour paste mixed with milk, pinch of salt and lime, dried yeast, lean meat, lettuce.

Guinea pigs and rabbits: Plenty of succulent green vegetables—at least body weight daily. Carrots, turnips, dry sweet hay, clover, different grasses, dry grain, apples and apple parings, apple cores, pear peelings, tomatoes (for rabbits, twigs with bark for gnawing occasionally), water cress, wheat and oat shoots.

The insect cage. Grow some plants from seed-corn, wheat, clover, grass, etc., in a large pot of earth, or transplant weeds or other plants suitable as food for the insects to be kept. Press a large lamp or lantern chimney into the soil, fitting the plants inside it. A small container of water should also be fitted inside the chimney. Place the insects inside the chimney and close the top with wire screening or mosquito netting. When the insects have eaten the food within the container, move it to a new pot of plants.

Ant colonies. It is not difficult to establish ant colonies for observation. The Lubbock ant nest is well adapted for use in the schoolroom since it shows all the tunnels and chambers. Such a nest may be obtained from one of the scientific supply houses listed on page 95 of the *Guidebook*. It is not necessary, however, to purchase an observation ant nest, as one similar to the Lubbock nest can easily be constructed.

Obtain two pieces of glass about twelve inches square. Lay one piece of glass flat on a table and glue one-quarter-inch strips of wood around three edges, using water glass or glass cement. On the fourth side leave two openings. (These openings may be made by using three short pieces of wood instead of a long one. Put one piece at each end of the fourth side and one in the middle. This will leave two openings.) After the glue is dry, fill the frame with a mixture of sifted loam and sand, leaving a space in the center for the ant colony and spaces near the two openings in the frame, which are to be plugged later to keep the ants from getting out.

Ant colonies may be found beneath logs or stones, or in underground nests in gardens and lawns. When a colony has been found, look carefully for a queen or two. The queen can be identified by her large size. (*The National Geographic Magazine* for August 1943 gives the life of ants and shows in pictures the different ant forms.) With a trowel, scrape up a queen and as many of the other ants, eggs, and larvae as possible and take them home in a glass jar with a tightly screwed lid. Place the ants in the center space left in the ant nest. Then glue on the top piece of glass. In one of the holes in the frame place a small sponge, which must be kept wet, as ants cannot be left without moisture. The other hole is for food. Bind all the edges with glass adhesive tape. Then plug the two holes with removable stoppers. Feed the ants from time to time, dropping bits of meat, bread, grains, sugar, drops of honey, and dried insects into the food hole. Keep the frame covered to exclude all light for a day or two. By then, the colony will be established and can be observed.

The aquarium. A square or oblong tank aquarium is the best type that can be had. Lacking that, the ingenious teacher will find many good substitutes, such as large-mouthed battery jars and fruit jars. Globes are not as desirable as other types, for they distort the appearance of animals and break easily. Thoroughly clean sand, natural objects that are found in streams (such as attractively colored pebbles that have been shaped by water action), and the proper kinds of plants and animals are the materials necessary for stocking an aquarium. A small net, rubber tubing for a siphon, and long-handled forceps are desirable.

SETTING UP THE AQUARIUM. Clean the container thoroughly. Put in a one- to two-inch layer of clean sand. Place the aquarium where it is to stay permanently. The most desirable place is one where it will not receive much direct sunlight, but plenty of diffused light, such as near a north window.

The close observer in the field will need no special instruction as to the types of plants desirable for the aquarium. Eel grass, water milfoil, pond weed, water cress, and certain kinds of algae can be collected from the habitat where they are growing and placed in the tank to grow under similar conditions. The florist or pet shop can furnish such cultivated varieties as vallisneria, sagittaria, elodea, ludwigia, etc.

In arranging the plants and natural objects, try to make them resemble a natural pond. Anchor each plant in the sand at the bottom of the aquarium by embedding about an inch of the base of the stem and placing pebbles around the base. The upper part of the plant can then be allowed to lie flat on the sand, as it will straighten to an upright position when the water is put in.

Place a large piece of paper over the plants and the sand, and siphon the water gently in on top of it. The paper will prevent displacing the sand as the water is poured in and should be removed when the aquarium has filled. Use water from a spring or clear stream, as tap water often contains chemicals that are harmful to animal life. Let the aquarium stand for several days until the plants adjust themselves. Then put in the animals.

A good caution is not to overstock the tank. The fish rule is "one inch of fish to one gallon of water." This does not include insects, tadpoles, etc., the number of these depending upon the size of the aquarium. An average amount of animals for one gallon of water is one one-inch fish, one tadpole, one snail, and several water insects. Goldfish should not be used in a school aquarium unless native types cannot be obtained. Use familiar animals that have been collected by the children, if possible. Some native fish that thrive in an aquarium are catfish, mud minnows, sticklebacks, and perch. Snails of the common fresh-water type are desirable as scavengers. Clams and fresh-water mussels should be used if possible. One is usually sufficient for an average tank. Very small turtles (one inch in diameter across the back) may be used. They must be well fed so that they will not disturb other animals. Rocks projecting out of the water must be provided for turtles, so that they can get above the water to breathe. Bullfrog tadpoles and newts or salamanders may be taken from springs and streams. Desirable insects are dragonfly nymphs, back swimmers, water boatmen, water striders, and whirligig beetles.

Feeding. Feed sparingly, once a day on the average, and remove excess food as soon as the animals have eaten. Prepared fish food of several types is easy to use and suits many animals. A worm suspended on a string is a good change of diet. Small flies, water plants, and other natural foods, noted by observing animals' habits, should be provided. See the food list on page 90.

Caution: Watch the aquarium closely. The water may have to be changed often at first. *Animals use the oxygen of the water for breathing, while plants use the carbon dioxide which is a waste product of animal life. Plants make oxygen. In this way the balance of aquarium life is maintained.* Do not overfeed animals. Remove dead animals and plants immediately.

Plants

Pots and window boxes. Temperature. A daytime temperature of 65-70 degrees and a night temperature of 55-60 degrees is desirable in the schoolroom for normal plant growth. When the outside temperature is excessively low, protect the plants from freezing by placing newspapers between them and the windowpanes.

Water. Water the plants only when they need it—when the soil is dry. Enough water should be given at one time to wet the soil to the bottom of the pots. Then wait until the soil is dry before watering again. Sprinkle the leaves thoroughly once a week in order to keep them free of dust and soot (with the exception of African violets, whose leaves should not be wet).

Pests. Plants are frequently attacked on the underside of the leaves by small green lice, mealy bugs, and scales, which are lice with hardened outer coverings. To rid the plants of lice and mealy bugs, wipe the under parts of the leaves with soapy water made with a mild soap. Scales can be removed only by using a toothpick or dull, pointed knife to lift them. Then wash the affected parts with soap solution.

The terrarium. A moisture-tight container such as was used in the aquarium work is best suited to terrarium construction. It should be either square or rectangular because of the better view afforded. If the straight-sided type cannot be had, any glass jar or container may be used. The larger ones are more desirable. Use a piece of plain window glass for a cover.

Almost any plant that grows in the local environment may be raised successfully by simply noting its growing conditions and reproducing them as nearly as possible in the terrarium. Delicate plants that would die in a few days otherwise may be made to live for long periods in a properly regulated terrarium. The secret of success lies in controlling the moisture by means of a tight glass cover. Plants which require little or no moisture may be kept in containers with screen covers, or with glass covers and the presence of little moisture.

The terrarium should be placed where it will receive plenty of light and, if possible, a little early morning sunlight. Care must be taken that it does not receive enough direct sunlight to make the plants "scald" because of too high temperatures. A northeast window is ideal for the average terrarium. The desert type should be placed where it will receive plenty of sunlight for most of the day. Place the container in the location where it is to stay and leave it, as continual moving of the container is bad for both plants and animals.

Ordinary room temperatures are suitable for plants and animals usually found in the vicinity. If the temperature of the schoolroom falls very low over weekends, very little success can be expected. An average nightly temperature of 50 degrees and a daytime temperature of 75 degrees will give good results.

One of several kinds of habitats may be established in the terrarium, but only a few of the most common types will be discussed here. Establish first those that match the environment near the school and those with which the pupils are most familiar. Others may be established to show different conditions as interest grows.

WOODLAND TYPE. In the bottom of the container, place a layer of sand or coarse gravel about an inch and one-half thick. On top of this, place a layer of loose rich humus from the forest floor. On field trips with the children, select small plants that are found growing in the deep woods. Place in this miniature woodland such animals as may live there. A small salamander (land type) and two small toads will make a good collection. A small snake may be added if desired. Keep the soil moist, but do not allow the water to stand for long periods of time. Feed the animals with small insects such as house flies, worms, and small strips of liver. Keep the terrarium covered with glass. Exclude most direct rays of sunlight.

MARSH TYPE. Place a layer of gravel on a slope, so that it will be about four inches high at one end and about one inch at the other. Cover this layer with rich, moist earth from a bog. Put in plants that require much moisture —mosses (sphagnum is good), small clumps of marsh grass, and similar plants. Place water plants (see directions for aquarium), and put about two inches of water in the lower end. Animals such as small turtles, a small fish or two, a tadpole, small frogs, etc., will complete the animal life. Feed as directed on page 90 and keep covered.

DESERT TYPE. Construct this type of terrarium when a study of conditions prevailing in very dry countries is desirable. Use coarse gravel covered with sand as a base. Place small cactus plants of various types in natural positions. Cover the roots completely. Water very sparingly once every two or three weeks, as the plants tend to decay if watered too often. Keep a small pan of water in one corner for the animals to drink from. Animals such as horned toads and fence lizards may be kept successfully. Feed as directed on page 90. Cover the terrarium with screen wire.

List of Materials

The materials needed for the experiments and observations described in the pupil's book are listed below. Many of the items may be brought from home by the pupils. Some may be borrowed from upper-grade science rooms. Others may be bought locally in ten-cent stores, drug stores, hardware stores, pet shops, feed stores, florist shops, greenhouses, etc. It may be necessary to order a few items from supply houses. These items are printed in heavy black type. The names and addresses of the supply houses are given on page 95.

QUANTITY	ITEM
1	**Aquarium** or large glass jar
1	Ball, rubber (size of tennis ball)
6 dozen	Bean seeds
1 sheet	Blotting paper
1	Boat, toy
–	Bones or skull of animals
1	Box, small cardboard (about 3 inches deep)
1	Box or cage, for larva
1	**Bunsen burner** or source of heat
Several	Cardboard, large pieces
1	Celery stalk
2 yards	Cloth
–	Coins: 1 quarter or half dollar; 1 copper penny; 1 silver dime
1	**Compass,** with colored needle
1	Cork
1	Cork, flat piece
2 handfuls	Corn seeds
1	Cornstalk
1	Cup, metal
1	Darning needle, large steel
1	Dish, shallow
1	Eraser, rubber
1	Flashlight
1	Flower pot, small, unpainted
–	Food for larva
–	Frog or toad eggs
1	Glass (tumbler)
1	Glass object
1 piece	Glass, window pane
1	Globe
–	Ice, cracked
1 bottle	Ink, red
1 bottle	Ink, waterproof black
–	**Iron filings**

QUANTITY	ITEM
–	Iron, small pieces
1 box	Iron tacks
1	Key, brass
1	Knife
1	Knitting needle, steel
1	Larva or chrysalis of a butterfly (Monarch, if possible)
1	Larva or cocoon of a moth (Cecropia, if possible)
2	**Magnets, bar,** marked N and S
2	**Magnets, horseshoe,** marked N and S
1	**Magnet, U,** unmarked
2	**Magnets, U,** marked N and S
1	Magnifying glass
1 dozen	Nails, iron
Several	Needles, small
1	Orange
1	Pan, deep
–	Paper, scraps of
1	Paper bag
1 box	Paper clips, steel
1	Pen
Several	Pen points
–	Pins
4	Plants, potted, small geranium
1 pr.	Pliers
1	Rubber band
1	Rubber stopper (to fit hole in small flower pot)
1	Ruler
–	Salt
–	Sand
–	Sawdust, box of
–	Sealing wax (or paraffin)
–	Soil, box about 4 inches deep; 2 boxes about 2 feet square

QUANTITY	ITEM
1	Stand, wooden
–	Steel, small pieces of
1-2 yards	String or twine
1 teaspoon	Sugar
Several	Tadpoles
1	Top
–	Twigs, large, without leaves (horse chestnut, cottonwood suggested)
1	Umbrella, dark colored
–	Vaseline
1 piece	Wire, stiff, 1 foot long
2 pieces	Wire screen
–	Wood, pieces sawed to show the cross section of a tree trunk
Several	Wood, small pieces
1 doz.	Wooden sticks, small, flat, for plant labels
1	Yardstick

Supply Houses

Biological Supply Company, 1176 Mt. Hope Avenue, Rochester 7, N. Y.
Cambosco Scientific Company, 37 Antwerp Street, Boston 35, Mass.
Carolina Biological Supply Company, Elon College, North Carolina.
Central Scientific Company, 1700 Irving Park Road, Chicago 13, Ill.; 441 Clinton Avenue, Newark 8, N. J.; 79 Amherst Street, Cambridge 42, Boston, Mass.
Chicago Apparatus Company, 1735 N. Ashland Avenue, Chicago 22, Ill.
Clay-Adams Company, 44 East 23rd Street, New York 10, N. Y. (models, charts)
Denoyer-Geppert Company, 5235 Ravenswood Avenue, Chicago 40, Ill. (models, charts)
Eimer and Amend, 633 Greenwich Avenue, New York 14, N. Y.
General Biological Supply House, 761-763 East 69th Place, Chicago 37, Ill.
Heil Corporation, 210 South 4th Street, St. Louis 2, Mo.
Marine Biological Laboratory, Woods Hole, Mass.
Millard-Heath Company, 325 Olive Street, St. Louis 2, Mo.
New York Scientific Supply Company, 28 West 30th Street, New York 1, N. Y.
A. J. Nystrom & Company, 3333 N. Elston Avenue, Chicago 18, Ill. (charts)
Oregon Biological Supply Company, 303 N.E. Multnomah, Portland 12, Ore.
Scientific Supplies Company, 122 Jackson Street, Seattle 4, Wash.
Standard Science Supply Company, 1232 N. Paulina Street, Chicago 22, Ill.
Standard Scientific Supply Corporation, 34-38 West 4th Street, New York 12, N. Y.
Tricker, William, Inc., Tanglewood Drive, Independence, Ohio; Saddle River, N. J.
Ward's Natural Science Establishment, Inc., 3000 Ridge Road, East, Rochester 9, N. Y.
Welch (W. M.) Scientific Company, 1515 N. Sedgwick Street, Chicago 10, Ill.

Visual Aids

American Museum of Natural History, Central Park West at 79th Street, New York 28, N. Y. Loans teachers silent and sound films, lantern slides, and cased collections.
Association Films (Y.M.C.A. Motion Picture Bureau): 347 Madison Avenue, New York 17, N. Y.; 19 South LaSalle Street, Chicago 3, Ill.; 3012 Maple Avenue, Dallas 4, Texas; 351 Turk Street, San Francisco 2, Calif.

Bray Studios, Inc., 729 Seventh Avenue, New York 19, N. Y. Films on many subjects.

Bristol-Meyers Co., Educational Dept., 630-C 5th Avenue, New York 20, N. Y. Wall chart showing teeth and their care.

L. W. Brownell, 176 East 32nd Street, Paterson, N. J. Slides on birds, mammals, reptiles, insects, botany.

Encyclopaedia Britannica Films, Inc., 20 North Wacker Drive, Chicago 6, Ill. Films on all subjects. (Has libraries formerly belonging to Eastman and Erpi.)

Films, Incorporated, Education Department: 330 West 42nd Street, New York 18, N. Y.; 611 Tillamook Street, Portland 12, Ore.; 64 East Lake Street, Chicago 1, Ill.; 101 Marietta Street, Atlanta 3, Ga.; 109 North Akard Street, Dallas 1, Texas.

General Electric Company, Educational Service Division, Publicity Department, 1 River Road, Schenectady 5, N. Y. Write for catalog. Motion pictures distributed through local offices.

Keystone View Company, Meadville, Pa. Lantern slides for courses in biology.

Metropolitan Life Insurance Company, 1 Madison Avenue, New York 10, N. Y. Films on medicine, nutrition, safety.

National Audubon Society, 1000 Fifth Avenue, New York 28, N. Y. Lantern slides of North American birds and mammals.

New York University Film Library, 26 Washington Place, New York 3, N. Y.

Santa Fe Film Bureau, 1401 Railway Exchange Bldg., 80 East Jackson Blvd., Chicago 4, Ill. Films on canyons in the west and on locomotives. Free.

Society for Visual Education, Inc., 100 East Ohio Street, Chicago 11, Ill. Films, slides and slidefilms, kodachromes, and charts on all subjects.

U. S. Department of Agriculture
Films: Motion Picture Service, U. S. D. A., Washington 25, D. C.
Information on slides: Extension Service, U. S. D. A., Washington 25, D. C.

U. S. Public Health Service and, in many cases, your state Board of Health will have a film library or list of recommended aids.

United World Films, Inc., 445 Park Avenue, New York 22, N. Y. (Now own the large film library of Bell and Howell.)

Visual Aids Service of New Jersey State Teachers College Library, Upper Montclair, N. J. Maintains an up-to-date card catalog and will furnish information relating to suitable audio-visual and teaching aids.

Westinghouse Electric Corp., 306 Fourth Avenue, Pittsburgh 30, Pa. Sends free films and charts on physical sciences and health.

Many public school systems and state universities have departments of visual education which maintain film libraries. State museums often loan slides to teachers.

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 55 54 53 52 51

BASIC STUDIES IN SCIENCE

Discovering Our World

SCIENCE FOR THE MIDDLE GRADES

by WILBUR L. BEAUCHAMP
MARY MELROSE WILLIAMS
GLENN O. BLOUGH

1

SCOTT, FORESMAN AND COMPANY
Chicago, Atlanta, Dallas, New York

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CONTENTS

To the boys and girls who study this book . . 6

UNIT ONE: *How are the things of the world put in groups?* . 9
- What are the two big groups of things? 10
- How are all living things alike? 12
- How are all non-living things alike? 15
- What are the two biggest groups of living things? 17
- How can we tell what group an animal belongs in? 19
- What is a mammal? 21
- How are birds different from other animals? 24
- How are all reptiles alike? 26
- How are all fish alike? 30
- What are amphibians? 31
- How are all insects alike? 33
- Are there other groups of animals? 36
- What are the two big groups of plants? 38

UNIT TWO: *Why do all living things need air and water?* . 47
- What is air? 48
- Where is air found? 50
- What part of the air do animals need? 52
- How do plants get and use air? 54
- Where is water found? 56
- Why must plants have water? 59
- Why do animals need water? 62

UNIT THREE: *How does your body work?* 67
How is your body like a machine? 67
How do your bones help you? 70
How can your body move? 73
How does your body use the food you eat? 76
How is food carried to all parts of your body? 78
How do all parts of your body get oxygen? 80
What does your skin do for your body? 82
How do you know what goes on around you? 83
What keeps the parts of your body working together? 86

UNIT FOUR: *Why do we have days and nights?* 91
How does the earth get its light? 91
What is the shape of the earth? 94
How does the earth move? 96
Why do we have daylight and darkness? 98
How is the earth like a clock? 100
What makes a year? 104
How do the hours of daylight
and darkness change during the year? 105
Why are summer days warmer than winter days? 107

UNIT FIVE: *What can we see in the sky at night?* . . . 113
What is a star? 113
What is a constellation? 115
Why do the constellations seem to move? 122
How is the moon different from the stars? 124
What is the moon like? 125
Why does the moon seem to change its shape? 127
What is a planet? 130
Are there living things on the planets? 133
What are shooting stars? 134

UNIT SIX: *What can magnets do?* 139
What kinds of magnets are there? 140
What kinds of things will a magnet pick up? 141
What kinds of materials will the force of a magnet pass through? 143
What are the poles of a magnet? 144
How do magnets act toward each other? 147
Why will a magnet point toward the north and the south? . . . 149
How can you make a compass? 150
How can you use a compass? 153

UNIT SEVEN: *How can you keep well?* 157
How do you feel when you are sick? 158
How can you help keep your body well? 160
How does food help you keep well? 166
Why do you need exercise and rest? 169
How can the right clothes help you keep healthy? 170
How can you keep from catching diseases? 172
How can you keep from having accidents? 174

UNIT EIGHT: *How do animals and plants grow?* 183
What happens when animals grow? 184
How do insects grow? 186
How do amphibians grow? 191
How do other groups of animals grow? 194
How do plants with seeds begin to grow? 197
How do plants grow taller? 200
How do the roots of plants grow longer? 202
How do the stems of plants get thicker? 205
In what directions do the parts of plants grow? 208

SCIENCE WORDS 215

INDEX 219

To the Boys and Girls Who Study This Book

From this book you will discover many things about the world you live in. If you looked at the Contents on pages 3-5, you know that the book is about plants and animals, about your own body, about what makes day and night, about the stars, about magnets, and about many other things that you see every day.

You will discover some of these things by reading. Some of them you will discover by looking at the pictures. Some you will discover by *experimenting*. Experimenting means trying them out yourself. Some you will discover by looking about you. Stop, look, and listen. And you will discover that the things told in this book really happen in the world you live in. Will the children in the picture on this page discover something about their world?

Someone had to discover the things that are in this book. Some were discovered long ago by people who were interested in the world around them. They watched plants and animals growing. They watched the stars and the moon. They noticed things about the earth. They could not always explain the things they saw. But they discovered many of the things that we know about today.

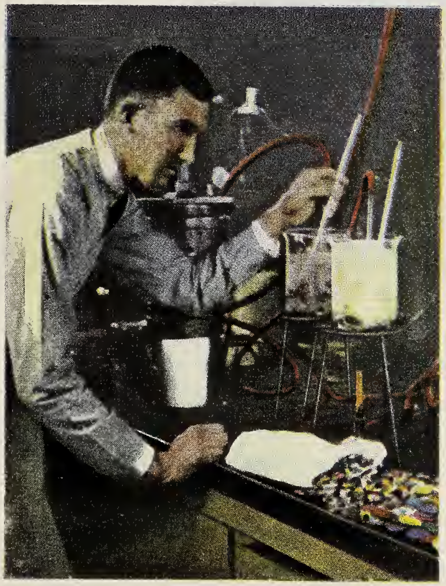
Many of the things in this book were discovered by men and women called *scientists*. Scientists have learned ways of studying the things they see. They find out about them by examining them, by using instruments, and by experimenting. By using these ways, scientists can discover new things. And they can explain some of the things that people saw but did not understand.

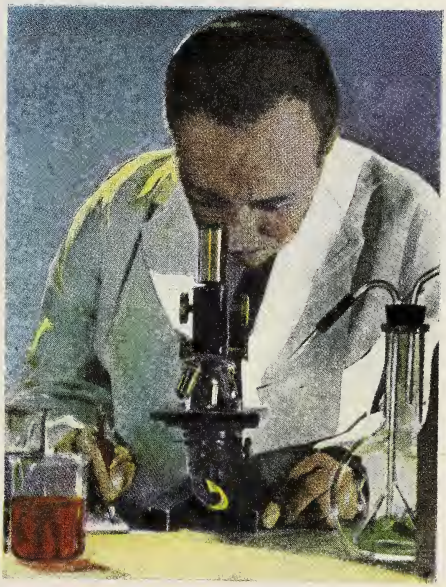
On this page are pictures of two scientists at work. One is using an instrument called a *microscope* to look at something that is very, very small. The other is doing an experiment. He is *testing* buttons made of a new material. He wants to find out what happens to them when they are put into very hot water.

As these scientists work, they follow certain rules so that they can be sure that what they discover is really true. They work carefully to discover the answers to questions. They always examine things very carefully. They try experiments over and over before they believe what the experiments show. They think things over before they say what they believe.

When you use this book, you will learn more if you follow these rules. Try to read carefully, examine things with care, do the experiments just as the directions tell you to, and do not decide that a thing is true before you have thought carefully about it.

If you follow these rules, you will discover many things about the world you live in. You will learn what happens to a tadpole's tail, what happens to the sun at night, and why winter comes. You will find the answers to hundreds of other questions. It took scientists many years to discover the answers to these questions. You can discover them very easily for yourself by studying DISCOVERING OUR WORLD.





★ *In Unit One You Will Learn* ★

★ What the two big groups of things are ★ How all living things are alike ★ How non-living things are alike ★ What the two biggest groups of living things are ★ How we can tell in what group a living thing belongs ★ What mammals, birds, reptiles, fish, amphibians, and other animals are ★ ★ What the two big groups of plants are ★

★ UNIT 1 ★

How Are the Things of the World Put in Groups?

On the second day of school Robert came hurrying home as fast as he could.

"Mother," he said, "is there any more of that wallboard that Dad used to make the room in the attic?"

"Yes," answered his mother, "there are some small pieces left, I'm sure. What do you want them for?"

"I want to get my butterflies ready so that I can take them to school tomorrow. Those soft boards will be just the thing. I can pin the butterflies to them easily. Our teacher wants us to bring anything we've collected outdoors. She said to bring pet animals, too, and some plants."

So Robert went to work with his butterflies. He found some cardboard boxes and sawed the wallboard to fit inside them. Then he pinned the butterflies to the boards and put them in the boxes.

Next morning Robert's mother helped him tie his boxes together so that he could carry them safely.

When he came into the schoolroom, the others in the class crowded around to see what he had. His teacher came to look at Robert's butterflies, too.

"You had better put them on the shelf, Robert," she said. "Everyone can see them easily there."

The other boys and girls had also brought things. "The rest of you may put your things there, too," the teacher said.

This shelf was about two feet wide and just high enough for the boys and girls to see everything that was on it. It was much like the shelf in the picture on page 11.

While the children were looking at Robert's butterflies, they asked him one question after another about them. He was glad he could answer so many of the questions. At last, John asked, "How did you learn so much about butterflies?"

"By watching them," answered Robert, "and by reading about butterflies in a book I got from the library."

Robert had told his classmates two of the best ways of learning about the things that we see around us every day. Watch things closely and read about them.

If you keep your eyes open, you will surely see many things that will interest you. You will want to ask questions about them. Your teacher will help you find answers to your questions. And books will answer questions for you, too. But you will want to find answers by yourself whenever you can. Your eyes, your ears, your fingers, and even your nose will help you find the answers to questions.

The next day more of the boys and girls brought things for the science shelf. They brought grasshoppers, a stuffed squirrel, white rats, stones, a crayfish, colored glass, a clam shell, snails, snakes, plants, and many other things they had collected.

What are the two big groups of things?

"IF YOU PUT these things in some order, it will be much easier to learn about them," said the teacher one day. "We have the snakes next to the stones, the butterflies next to the white rats, and the grasshoppers beside the stuffed squirrel. I think we should put them in some kind of order."

"I know what you mean," said John. "My father keeps different sizes of nails in separate boxes, and he has other boxes with a different kind of thing in each box. I know just where to look when I want to find a big nail or a little tack."

"That's good, John," said the teacher. "But what should we do with all our things to put the shelf in order?"

"Oh, I know," said John. "Let's put the things that are like each other together."

John's plan was a good one. It is the way scientists work. They separate things into different groups. Each group is made up of things that are like each other. So the boys and girls looked carefully at all the things. They began to think about why some of the things belonged together and why some did not belong together.

Here are the things the children in one science class brought to school. Someone even brought a pet porcupine!

Nancy was the first one to speak. "The rocks and glass don't belong with my cat and kitten," she said. "The cat and kitten are alive, but rocks and glass are not alive."

"That is a good way to begin," said the teacher. "We can put all the *living things* into one group and all the *non-living things* in another group."

All the things in the world can be divided into these two groups: *living things* and *non-living things*. A living thing is something that is alive now or that was alive at one time. When we say a thing is a non-living thing, we mean that it never was alive. Rocks and glass are things that never were alive.

---

1. *What are two good ways of learning about the world we live in? Tell something that you have learned this week by using these two ways.*
2. *What do your eyes, ears, fingers, and nose tell you about things?*
3. *Why did the teacher ask the children to bring many things to school?*
4. *Why is it a good idea to put things in groups?*
5. *Try to name ten living things and ten non-living things. Keep your lists. After you have read more in this unit, you can check them to see if they are correct.*

The pictures on these two pages were taken while this magnolia flower was opening. The pictures on this page show the tight bud and how it looked one hour later.

How are all living things alike?

THE BOYS AND GIRLS looked closely at a few things that they knew were living things—the cat and kitten, the snails, the stuffed squirrel, and the butterflies. The cat and kitten and the snails were alive, and the stuffed squirrel and the butterflies were once alive. Then the class started thinking and talking about how all these were alike. As they talked, the teacher wrote on the blackboard what they said about living things. This is the list she made.

1. Living things can move.
2. Living things can breathe.
3. Living things need food.
4. Living things can grow.
5. Living things can have young like themselves.

When she finished writing, the teacher said, "All living things can move, can breathe, need food, can grow, and can have young like themselves. Suppose you put each living thing at one end of the science shelf. But first, you must tell the class why you think each thing belongs to the group of living things."

"My cat and kitten are certainly living things," Nancy said. "They can move, and they breathe. They need food, too. I give them milk three times a day. And the kitten has grown, too. Cats can have young like themselves, for the cat is the kitten's mother."

The other boys and girls agreed with Nancy that the cat and kitten should be put with the living things.

The left-hand picture on this page was taken only fifteen minutes after the right-hand one on page 12. Forty-five minutes later the flower was open wide.

"My snakes are living things," said Henry. "They move so fast it's hard to catch them if they get out of the cage. Of course, they can breathe. They need food, too, and they have grown. Snakes can have young like themselves, for these baby snakes came from eggs that were laid by a snake."

Henry put the cage of snakes with the living things. And, one by one, the boys and girls picked out the living things and moved them to one end of the shelf.

Then Betty began to wonder if the petunia plant was a living thing. She could not see that the plant moved or breathed.

Perhaps you are like Betty and think that plants do not move and breathe. Of course, plants have no legs or wings with which they can move about from place to place. But if you saw a slow-motion picture of plants growing, you would be surprised. You would see stems shooting up and out, and buds swelling. You would see flowers opening as the magnolia flower in the pictures is doing. Then you would know that plants move as they grow.

Although a plant does not have a nose, it breathes in air. Later in this book, you will learn how plants breathe. You will also find out that plants need to have food to make them grow.

Betty knew that the petunia plant could produce other petunias because she had raised the plant from seed. She knew that the seed had come from full-grown petunia plants. So

she put the petunia plant with the living things. All plants are living things.

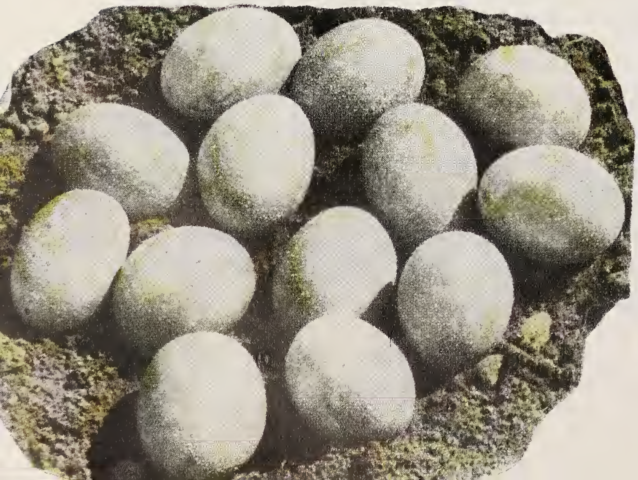
"Do these leaves from an oak tree belong with the living things?" asked Helen.

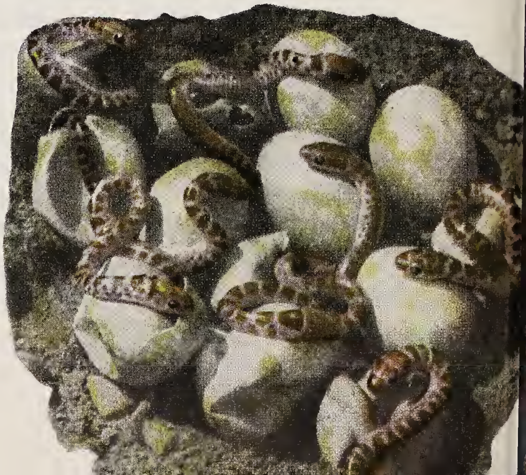
"Yes," explained the teacher, "they were parts of a tree. And a tree, you know, is a living thing. A piece of wood should also be put with the living things because at one time it was a part of a tree, too."

The class then put a feather, a snakeskin, some flowers, some pine cones, some snail shells, and a clam shell with the group of living things. Each of them was once a part of a living thing.

---

1. *In what ways are all living things alike?*
2. *Which of these would you put in the group of living things?*
   Fur Leather Paper Glass Hair Bone Iron
3. *Was your list of living things correct? How do you know?*
4. *The large zebra is the mother of the little one. The baby snakes came from eggs laid by a mother snake. Are zebras and snakes living things?*





How are all non-living things alike?

To help the boys and girls find out about non-living things, the teacher suggested that they compare a man with a snowman.

They knew that a man is a living thing. He can move and breathe. He needs food, has grown, and can have children. But the snowman cannot move itself, cannot breathe, cannot take in food, cannot grow, and cannot have young like itself. They decided that the snowman must be a non-living thing.

The class also compared a live duck with a toy duck made of metal. The toy duck cannot move, cannot breathe, does not need to eat food, cannot grow into a larger toy duck, and cannot have young toy ducks. Then the boys and girls knew that the live duck is a living thing but that the metal toy duck is a non-living thing.

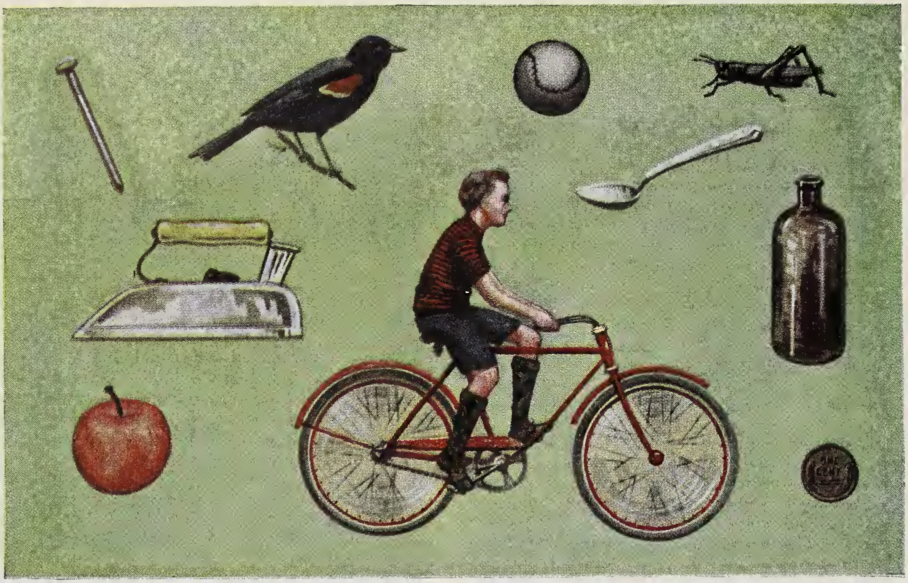
The teacher wrote on the blackboard what the class had found out about non-living things.

1. Non-living things cannot move.
2. Non-living things cannot breathe.
3. Non-living things do not need food.
4. Non-living things cannot grow.
5. Non-living things cannot have young like themselves.

How is a snowman different from a real man?

Henry picked up one of the stones in his collection. Of course, he knew it was a non-living thing. It did not eat food or breathe air. It would never grow from a small stone into a big stone. It could not produce more stones like itself, and it could not move itself.

Henry said that you could leave a stone by the side of a tree for years. The tree would grow larger, but the stone would not get bigger.



"A piece of glass has no eyes or ears, and it has no nose or mouth," said Peggy. "Non-living things can't see, hear, smell, feel, or eat."

A book, a vase, a glass, and a pair of scissors were some of the things the children put with the group of non-living things.

At last, the boys and girls had all of their things in two groups. They made one cardboard sign that said LIVING THINGS and put it at the end of the shelf where all the living things were. Another sign said NON-LIVING THINGS. This was put up in front of the non-living group.

---

1. *In what five ways are living things different from non-living things?*
2. *What does* non-living *mean?*
3. *Separate the things in the picture on this page into living things and non-living things.*
4. *Make a list of all the living things in the pictures in this unit.*
5. *Make a list of all the non-living things in the pictures in this unit.*
6. *Look at the list of non-living things you made to answer the question on page 11. Was the list correct? How do you know?*

What are the two biggest groups of living things?

Betty now looked at the two groups and said, "It didn't take long to get everything put in order, did it?"

But Betty did not know that the class had only just started. A scientist knows that everything in the world is either living or non-living. But a scientist needs to know more than that. He must know the different kinds of living things and the different kinds of non-living things.

"We can separate all living things into two big groups," said the teacher. "Will you look at the living things on the shelf? See if you can find out for yourselves what the two groups are."

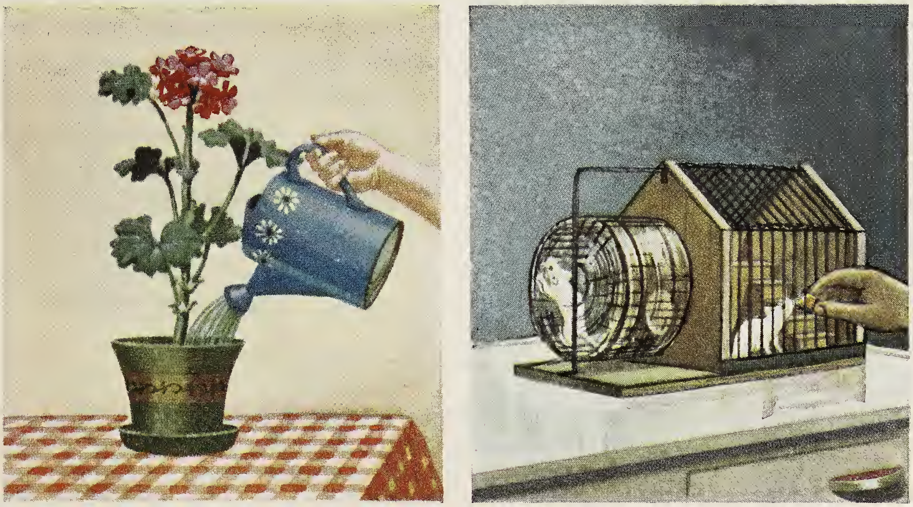
"Well, my white rats and Helen's geranium plant don't belong together," said Charley. "I think the two groups must be plants and animals."

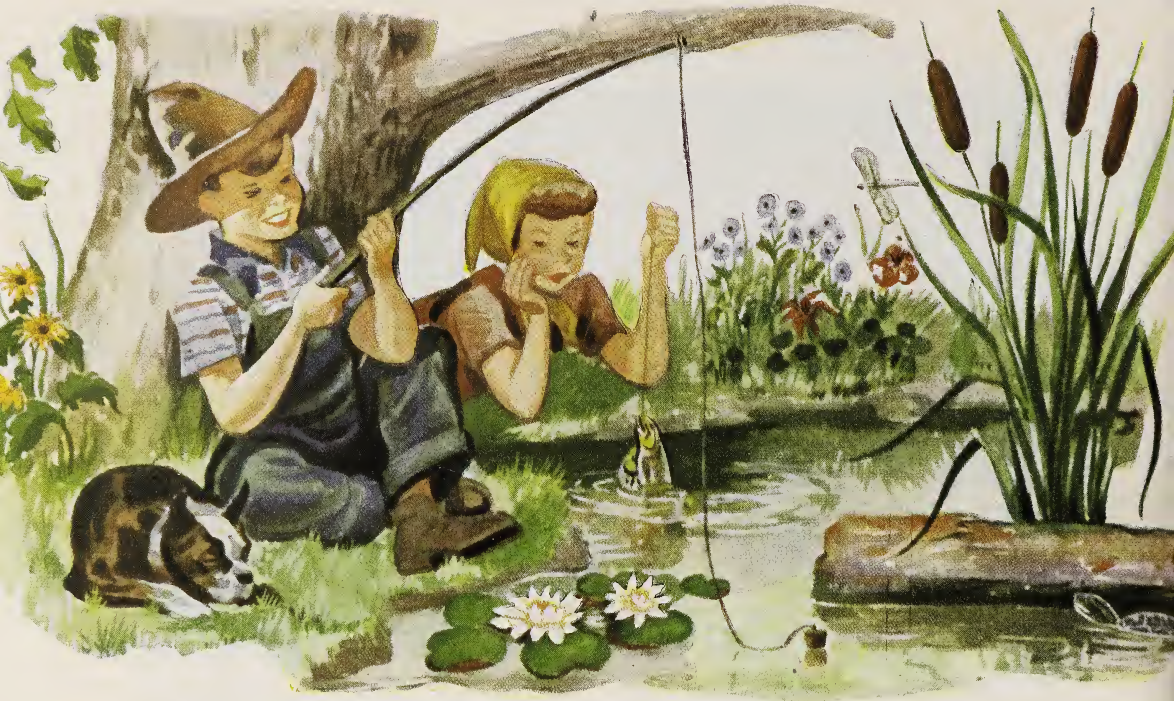
Charley was right. Every living thing is either a plant or an animal. So the class went to work, dividing their living things into the two groups. Of course, they had no trouble telling which things were plants and which were animals.

While the boys and girls were separating the plants and animals, Nancy began to be puzzled about something.

"We are certainly alive," she said. "So we must be either plants or ani-

How are the white rats different from the geranium plant?





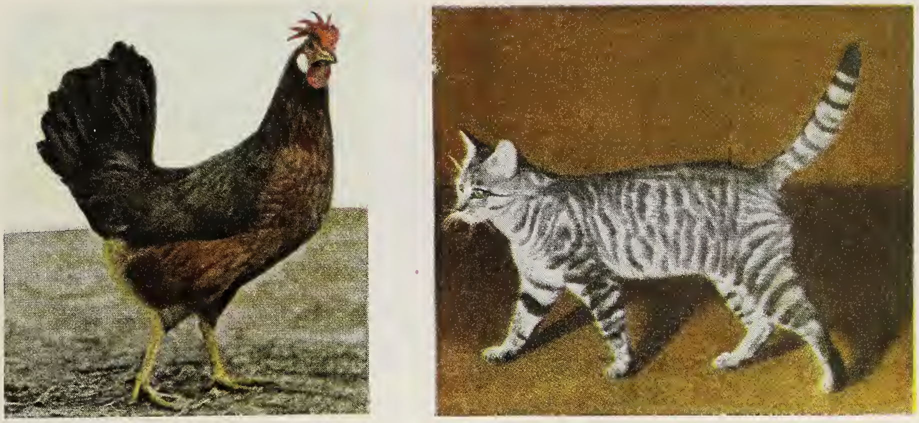
Which of the living things in this picture are plants? Which ones belong to the animal group?

mals. I know I am not a plant. Am I an animal?"

"Well, Nancy," answered the teacher, "you and I are living things, aren't we? We must belong in either the plant group or the animal group. You know that we are not plants. So you and I and all other people must belong in the same big group of living things as the animals belong in."

The boys and girls laughed. They said they did not know before that they were in the same group as cats, dogs, birds, and other animals. Soon they had all of the plants and animals on the shelf divided into two groups. They made two more signs. One sign read PLANTS. The other sign read ANIMALS. They put each sign with the group to which it belonged.

1. *How do you tell whether a living thing is a plant or an animal?*
2. *Make a list of all the plants shown in the pictures in this unit.*
3. *Make a list of all the animals shown in the pictures in this unit.*



Are the cat and the chicken made alike?

How can we tell what group an animal belongs in?

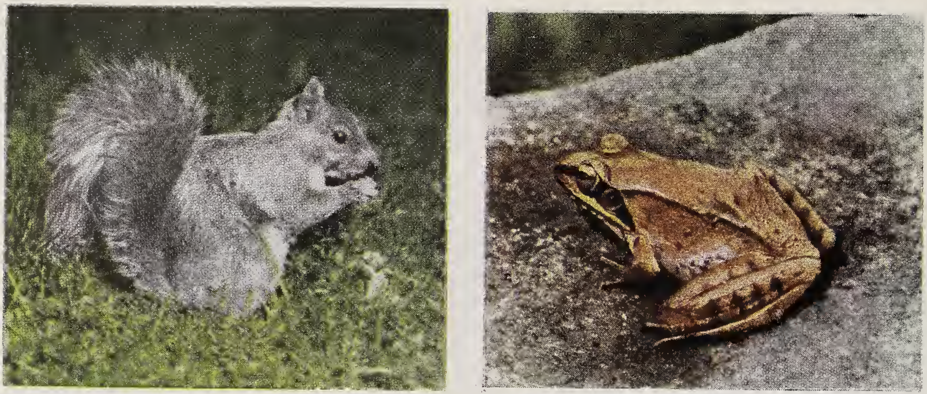
WHEN THE CLASS came in one morning, the teacher said, "Our next job is to divide all our animals into different groups and our plants into different groups. That is what a scientist does, and this is how he does it. A scientist studies things to see how they are made. He says, 'If they are made alike, they belong together. If they are not made alike, they do not belong together.' Are all the animals on the science shelf made alike?"

"Well, the snakes certainly aren't made like the rats," said Henry.

"That's easy to see," said John. "The rats have hair, and they walk on legs. The snakes have no hair on them, and they slide along on their stomachs. They aren't made like rats."

Then the boys and girls began to talk about all the differences they could find in the ways animals are made. They thought of two-legged animals, four-legged animals, and even eight-legged animals. They named animals that have no legs, some that have fins, and some that have wings. They had seen animals covered with hair, animals covered with feathers, animals covered with smooth skin like a frog's, and animals covered with shells.

Scientists have a word that they use when they talk about the way anything is made. The word is *structure*. Structure means the parts of a thing and how the parts are put together. Studying different animals will help you see what structure means.



How is a squirrel's structure different from a frog's?

How many differences can you find between the structure of a chicken and the structure of a cat? Before you can answer this question, you must know what parts a cat has and what parts a chicken has. Make a list of the parts of each animal. Then look at your lists and see what the differences in structure are. Here are the lists the class made. What differences in structure did they see when they looked at their lists?

A Cat's Structure	*A Chicken's Structure*
1. Four legs	1. Two legs
2. Hair	2. Feathers
3. Teeth	3. Two wings
4. Mouth and lips	4. A bill
5. A nose	5. Holes in the bill for a nose
6. Ears that stick out	6. Holes in the head for ears

---

1. *How are horses and dogs alike? How are they different?*
2. *How is the structure of a fish different from the structure of a bird?*
3. *How would you describe your own structure?*
4. *Why is it important for a scientist to know about the structure of an animal?*
5. *Choose an animal in one of the pictures in this unit and describe its structure. Do not tell your class which animal you have chosen. Try to describe its structure so carefully that they can guess which animal it is.*

What is a mammal?

"WE HAVE a good collection of animals here on our science shelf," said the teacher one morning. "And they belong to many different groups. Look at the cat, the white rats, and the rabbit. Think about their parts and then try to tell how these animals are alike."

John was the first one to answer. "Well," he said, "every one of these animals has four legs and two eyes."

"That's good, John," said the teacher, "but so does the frog. Do you think that the frog belongs to the same group as the cat, the rats, and the rabbit?"

John was not sure. Do you think the frog belongs with the cat, the rats, and the rabbit? Later on, you will learn with what group the frog belongs.

"Is there any other way the cat, the rabbit, and the rats are alike?" asked the teacher.

Quickly Mary spoke up. "They all are covered with fur," she said.

Mary had noticed an important thing. Fur or hair is one way that scientists tell this group of animals from all other groups. They call the animals in this group *mammals*. All mammals are covered with fur or hair, or else they have hair somewhere on their bodies.

As the children were looking at the animals, Peggy said, "Oh, look at the little kitten getting its dinner from the mother cat!"

Peggy had found another way in which all mammals are alike. Young mammals get milk from their mothers' bodies. Mammals are the only animals that feed their babies this way. All baby mammals are raised on milk.

These are two ways in which mammals are different from all other animals.

1. They have fur or hair.
2. They feed milk to their babies.

Is the giraffe a mammal? How do you know?

All of the animals on these two pages are mammals—even the strange-looking armadillo.

Then the teacher told the class two more very important things about mammals. First, she told them that mammals are *warm-blooded.* Do you know what warm-blooded means?

The temperature of the blood of a warm-blooded animal stays about the same all the time. You are warm-blooded. You may feel cold on a cold winter day, but your blood is as warm as it is on a hot day. On a hot day you may feel very warm, but your blood is no warmer than it is on a cold day.

The blood of every mammal stays at almost the same temperature all the time. So we say that mammals are warm-blooded.

The other important thing about mammals is the way they get air. Every living thing must have air to stay alive. But not all living things get air into their bodies in the same way. Mammals have *lungs.* When a mammal breathes, the air goes in through the mouth or nose and down into the lungs. The lungs help get the air into the body where it is used. Mammals must live in the air. Or if they live in the water, they must come up to the surface quite often to get air into their lungs.

So the children had learned four things that are true about all animals in the mammal group. These four things are listed on the next page.

Which of these mammals have you ever seen or read about?

1. Mammals have fur or hair.
2. The babies are fed with milk from their mothers' bodies.
3. Mammals are warm-blooded.
4. Mammals take air into their bodies with lungs.

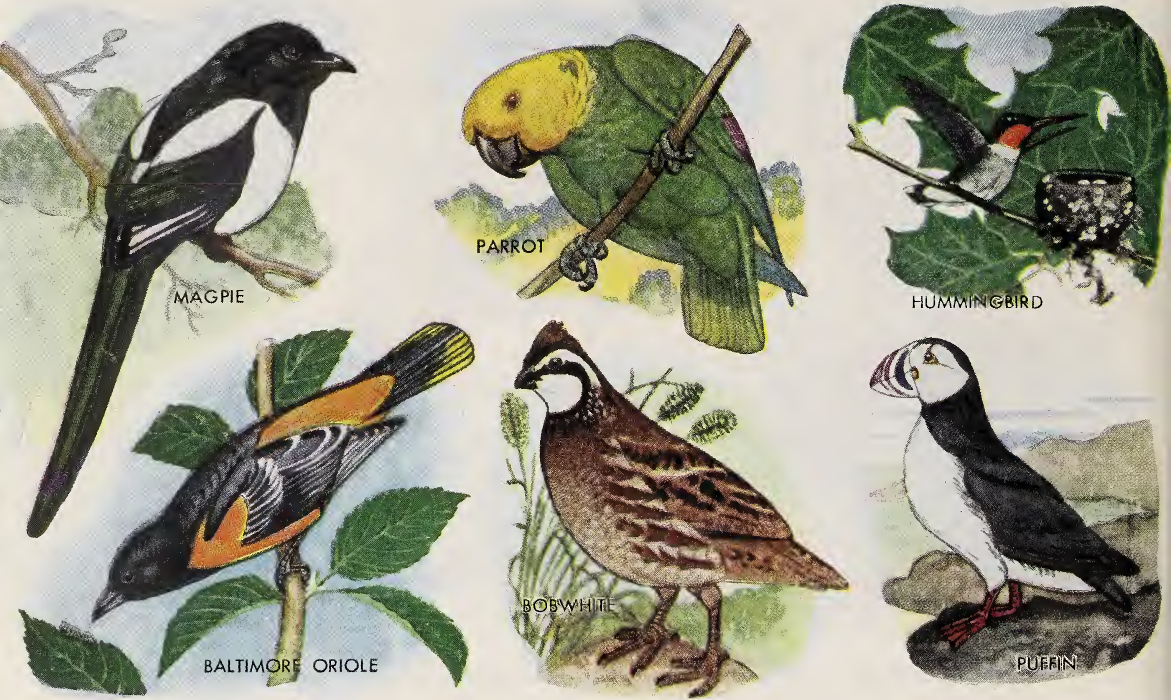
The teacher then asked the boys and girls to look carefully to see if they could find some other mammals in the room besides the rabbit, the rats, and the cat.

The children looked and looked. At last, Robert said, "I know. We are mammals."

Robert was right. We have hair. Our mothers can feed their babies with milk from their own bodies. We are warm-blooded, and we have lungs.

---

1. *Which of these animals are mammals? How do you know?*
   Dog Horse Frog Cow Snake Crow Beaver Lion
2. *Find all the pictures of mammals shown in this unit.*
3. *Why is it incorrect to say that mammals are animals with four feet?*
4. *How is a mammal like any other living thing? How is it different from any other living thing that is not a mammal?*
5. *Try to find out which mammals live in water.*



Some birds are very large. Some are very small. Some have strange shapes. But they all have the parts that show you they are birds.

How are birds different from other animals?

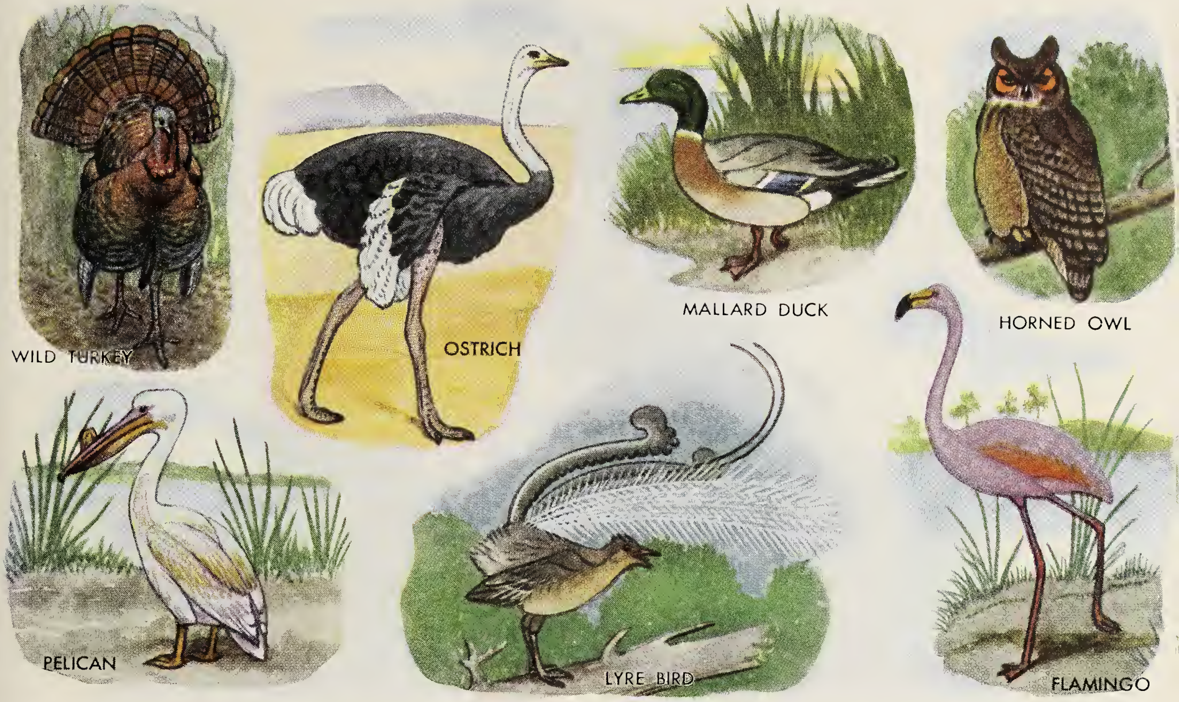
It was easy for the class to find out the important things about the structure of birds. Of course, they had all seen many different kinds of birds. They could look out of the schoolroom window and see bluejays, sparrows, and robins. Every bird they could think of had two wings, two legs, and feathers. They decided that all birds have this structure.

There is another important thing that the children noticed about the structure of birds. Do you know what the difference is between the mouths of birds and the mouths of other animals?

"When we looked at the chicken," said Peggy, "we saw that it didn't have any teeth. And I'm sure my canary has no teeth. The chicken and the canary have hard bills. They can use their bills to pick up food and crack seeds."

Peggy had discovered another important thing about birds. Birds do not have any teeth.

"Are birds warm-blooded like mammals?" asked Mary.



Do the birds in these pictures all have the same kind of bills? What different kinds of legs and feet can you find?

"Yes, Mary," answered the teacher, "birds are warm-blooded. On a cold day as well as on a warm day the temperature of a bird's blood is always warm. Birds are warm-blooded animals."

Then the teacher told the class another thing to remember about the structure of birds. All birds breathe with lungs.

The class was now ready to write on the blackboard the important things they had learned about the structure of birds.

1. Birds are covered with feathers.
2. Birds have two wings and two legs.
3. Birds have bills.
4. Birds are warm-blooded.
5. Birds breathe with lungs.

---

1. *How are birds like mammals? How are they different from mammals?*
2. *Is a duck a bird? How do you know?*
3. *Is a bee a bird? How do you know?*

The children are learning how to handle this harmless Indigo snake. This kind of snake makes an interesting pet and helps us by catching rats.

How are all reptiles alike?

SO FAR THE CLASS had discovered two animal groups — the mammals and the birds. They began to see that putting all the animals of the world into groups was quite a job. They discovered that they had to know a great deal about the parts of animals.

"What animals shall we study next?" asked Henry. "I'd like to know about my snakes. What group do they belong in?"

"You caught the snakes, Henry," replied his teacher, "and you have had plenty of chances to study them. What can you tell us about the structure of snakes?"

"Well," said Henry, "they haven't any legs or wings, and they are not covered with feathers or hair."

"Let's look closely at your snakes," said the teacher, "and find out what they are covered with."

So the boys and girls crowded around the box while Henry took out one of his snakes. He took hold of it just back of the neck and handled it very gently and carefully.

You must always be careful with snakes, just as you must be careful with any wild animal. Never disturb a snake when it is eating. When you pick up a snake, hold it just back of the head so it cannot bite you. Even though the snake is not poisonous, its bite could cause you trouble. Never get near a snake unless you are sure that it is not poisonous. If you are careful to follow these rules, you may enjoy having snakes as pets.

As the boys and girls looked at the snake carefully, Peggy said, "Why, it is covered all over with little *scales!*"

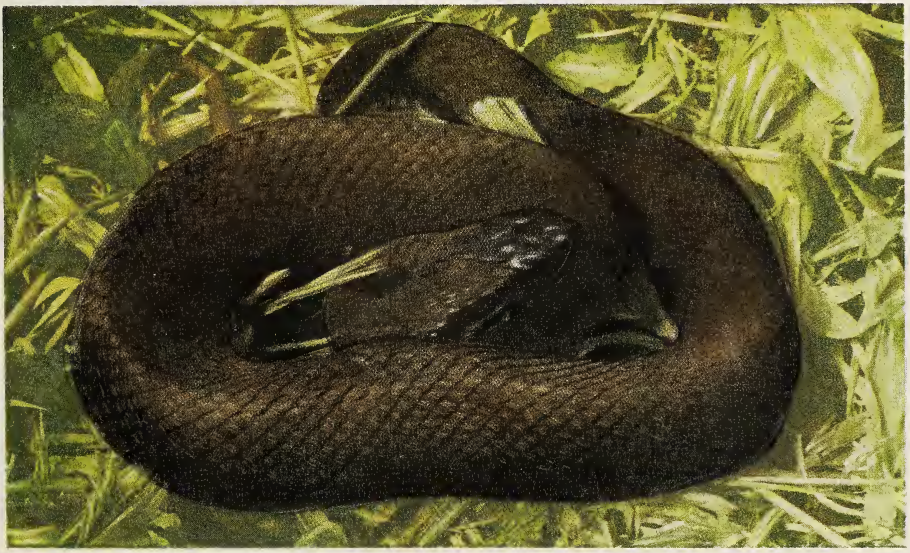
Then the teacher showed the children a big snakeskin that had been sent to the school. On this skin the boys and girls could plainly see the thin, flat scales. These fitted over each other like shingles on a roof. The class had discovered an important thing about another group of animals. The animals in this group are called *reptiles*. A snake is a reptile.

The class was just about ready to decide that all reptiles have scales like the scales on a snake. But the teacher said, "Let's look at another reptile before we decide."

She went over to where one of the boys had made a home for his turtles. "Are there any scales on this animal?" she asked, as she picked up one of the turtles and gave it to Billy to hold.

"Why, is this a reptile?" asked Billy. "It has legs, but snakes haven't."

You can plainly see the scales on this snake.



Can you see why a turtle belongs to the same group of animals as a snake?

"Yes," replied the teacher, "the turtle is a reptile. Reptiles have either very short legs or no legs at all."

"Well," said Billy, "I don't see any scales, but it has a hard shell."

When the children looked at the shell, they were surprised to find that it was made of scales. But these scales are different from those on the snake. The scales of the turtle fit together so closely that they seem to make one hard piece.

All reptiles have scales. A turtle has little scales on its legs and neck. Alligators, crocodiles, lizards, snakes, and turtles are all reptiles. They all have scales.

While the class was studying the snakes and turtles, Henry asked, "Are snakes, turtles, and other reptiles warm-blooded?"

"No, Henry," answered his teacher. "Snakes are not warm-blooded animals. They are *cold-blooded.*"

Then she explained what cold-blooded really means. It means that the animal's blood changes temperature when the temperature around the animal changes. When a snake is sunning itself on a rock, its blood is warm. But when the snake is in a cold hole in the ground, its blood is cold. All reptiles are cold-blooded.

"How do reptiles breathe?" asked Peggy. "Do they have lungs?"

"Yes, they have lungs just as birds and mammals have," answered the teacher. "Some reptiles live on land all the time, and others live in water all the time. Some live in the water part of the time and on land part of the time. But all reptiles breathe with lungs. Those that live in water must come up to the surface for air."

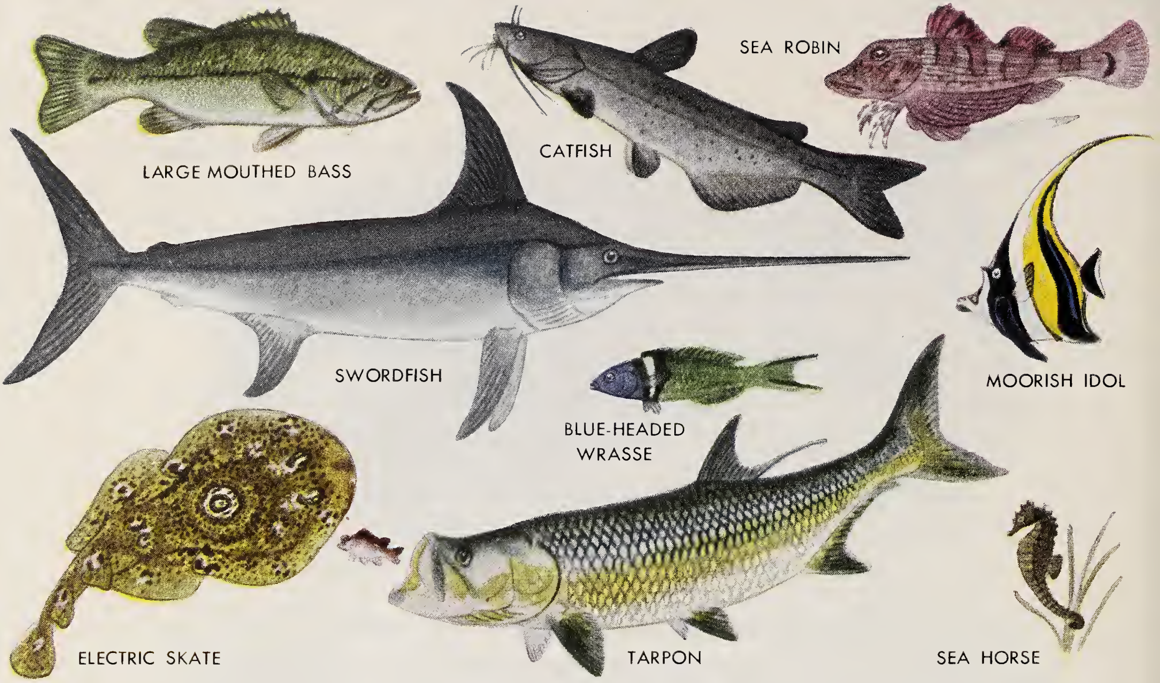
Now the class was ready to write on the blackboard the important things they had learned about the structure of reptiles.

1. Reptiles are covered with scales or a shell made of scales.
2. Reptiles have either very short legs or no legs at all.
3. Reptiles are cold-blooded.
4. Reptiles breathe with lungs.

---

1. *What are two ways in which reptiles are different from birds and mammals?*
2. *What is one way in which reptiles are like birds and mammals?*
3. *Which of these statements are right?*
    - *a) Snakes have scales.*
    - *b) All reptiles have legs.*
    - *c) Snakes have a different structure from birds.*
4. *What is the difference between* warm-blooded *and* cold-blooded?
5. *What rules should you remember so that you can enjoy having snakes for pets?*

Look at the picture and tell why these crocodiles are put in the reptile group.



There are many, many different kinds of fish. Some of them may not look much like fish, but they all have the same parts that every fish has.

How are all fish alike?

John had been on a fishing trip with his father just before school opened. He had seen three kinds of fish—perch, bass, and sunfish. He helped catch them, clean them, and eat them. So he had learned many things about them. One day in class he said, "I think fish must be reptiles. They are covered with scales, and I think they must be cold-blooded."

"You are partly right," said the teacher. "All fish are cold-blooded, and nearly all of them are covered with scales. But fish are not reptiles. Let's look at these goldfish. What can you see on the fish that you can't see on a snake?"

Peggy was quick to answer, "Fins."

"Yes," said the teacher, "fish have fins. Can you see any other difference between the snakes and the fish?"

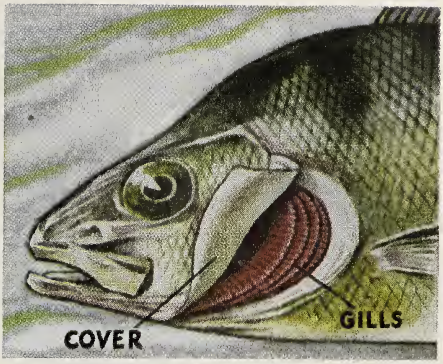
"I know," said John. "Fish have *gills*. I kept my fish on a string that I put through their gills and out through their mouths. Why do fish make their gills go in and out all the time, as these goldfish do?"

"The parts that you see going in and out are really covers for the gills," explained the teacher. "The gills are soft, thin parts under these covers. As the covers move in and out, water can go in and out over the gills."

Then the children watched the gill covers of a goldfish move in and out, in and out, as it breathed. The picture on this page shows you a fish's gills, too.

"Fish breathe through their gills," the teacher went on. "There is air in water. Fish can get the air from the water with their gills. All living things must breathe. You know that many animals breathe with lungs, but fish breathe with their gills."

The class then wrote on the blackboard the important things about the structure of fish.



The gill cover has been turned back to show the gills.

1. Fish are usually covered with scales.
2. Fish have fins.
3. Fish are cold-blooded.
4. Fish breathe with gills.

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1. *In what way is the structure of a fish different from the structures of the other groups of animals you have studied?*
2. *What are two ways in which fish and reptiles are alike?*
3. *In what two ways are reptiles and fish different?*

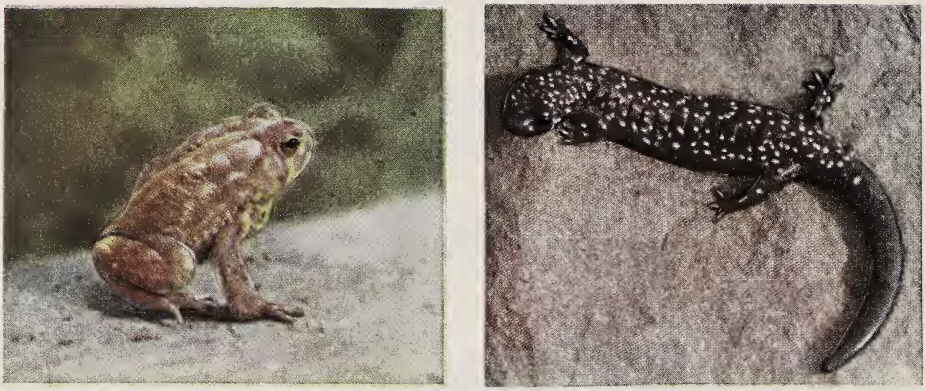
What are amphibians?

ONE DAY BILLY came to school much excited. "Come and see what I have in this box!" he called.

The boys and girls gathered close to see, but not one of them could name the animal that was in the box.

They asked their teacher to tell them what it was. But she only said, "Look at its structure, and perhaps you can find out what group it belongs in."

When the boys and girls looked at this new animal, they saw that its body was not covered with fur or hair or feathers. They said that they thought maybe it was a reptile. But they could not find any scales or a shell on it. Then Nancy said, "I think



The animal on the left is a toad. The one on the right is a salamander.

it's most like our frog. Anyway, it has a smooth, shiny skin like the frog's skin."

Nancy was right. The frog and the new animal belong in the same group. They are both *amphibians.*

The boys and girls looked through a book that told about amphibians. They found the picture of Billy's animal and learned that it was called a *salamander.*

Then the class began to look carefully at the frog and the salamander to find out for themselves all they could about the structure of amphibians. In the book about amphibians they learned that when an amphibian is young, it lives in the water and breathes with gills. When it grows older, it breathes with lungs and can live on land. Amphibians have no hair, no feathers, and no scales or shells. They are also cold-blooded. Toads, frogs, and salamanders belong in this group of animals. They are all amphibians.

These are the important things the class found out about amphibians.

1. Amphibians breathe with gills when young and with lungs when grown up.
2. Amphibians are covered only with skin.
3. Amphibians are cold-blooded.

---

1. *Which two ways of discovering did the boys and girls use? Have you used these ways as you studied this unit?*
2. *How are amphibians like fish and reptiles?*
3. *How are amphibians different from fish and reptiles?*

How are all insects alike?

For several days Robert had wanted to know where his butterflies belonged. At last, the teacher said, "Today, Robert, we will begin to study your butterflies and the other animals that belong with them. Let's see how crickets, grasshoppers, ants, bees, and butterflies are alike. These animals belong in the group called *insects.*"

"We will learn about the grasshoppers, the ants, the crickets, and Robert's butterflies at the same time. You may not think that they belong together. But when you study their structure, you will see why they do."

The class had enough insects in the cages and jars so that each boy and girl could study one of them. Some of the insects were dead, but that only made it easier to study their structure. Some of the live insects were put in small glass jars so that the class could watch them move.

Before the class began, the teacher wrote these questions on the blackboard for the class to answer.

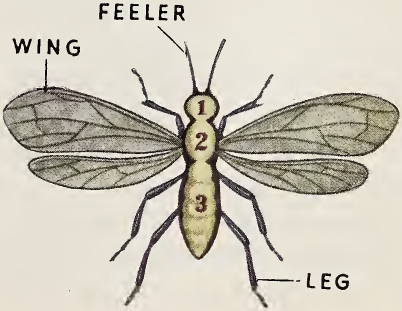
1. How many legs does the animal have?
2. How many parts has its body?
3. How many feelers does it have?
4. What is its body covered with?
5. How does it breathe?

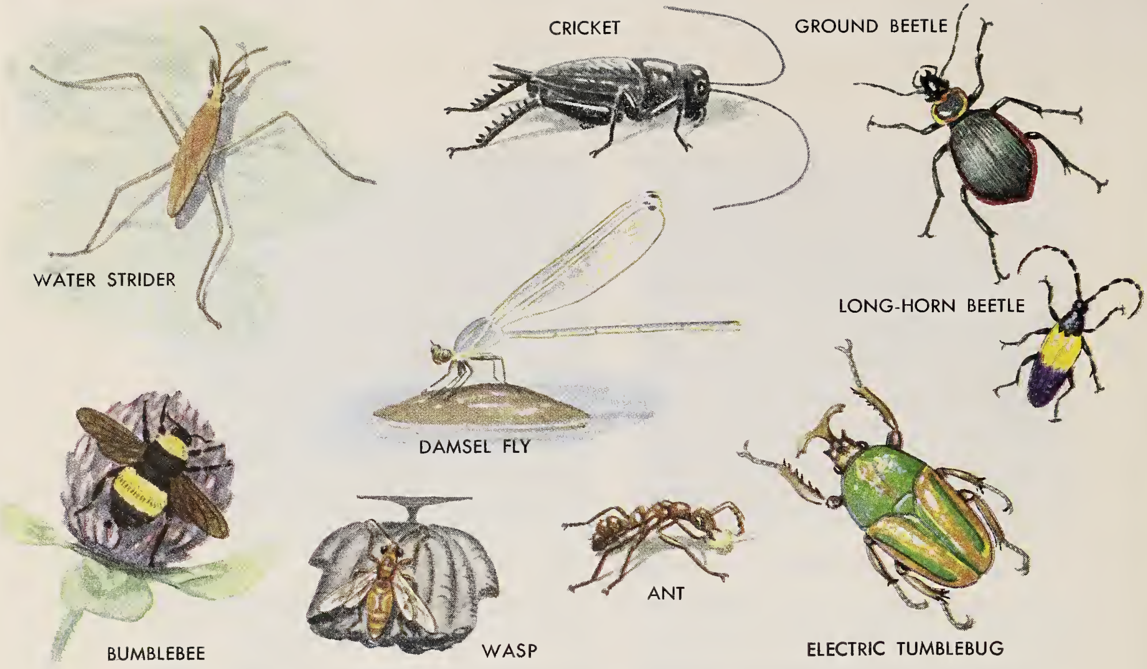
At last, the boys and girls were ready to tell what they had found. Betty told about the grasshoppers. She said, "A grasshopper has six legs. When we looked on the underside of the grasshopper, we could see three parts to its body. It seems to have some kind of covering over its body. We could see four wings. There are two feelers that stick out from its head."

Then John told about his ants. "An ant has six legs, too," he said. "You can see three parts to its body. And there are two feelers on its head. But my ants do not have wings."

Look at the picture on this page. You can see the parts that the children found on their insects.

The three parts of an insect's body have names. The part numbered 1 in the picture is its *head.* The middle part, numbered 2, is called the *thorax.* The part numbered 3 is called the *abdomen.*





There are more animals in the insect group than in any other. These are just a few of the many different kinds of insects.

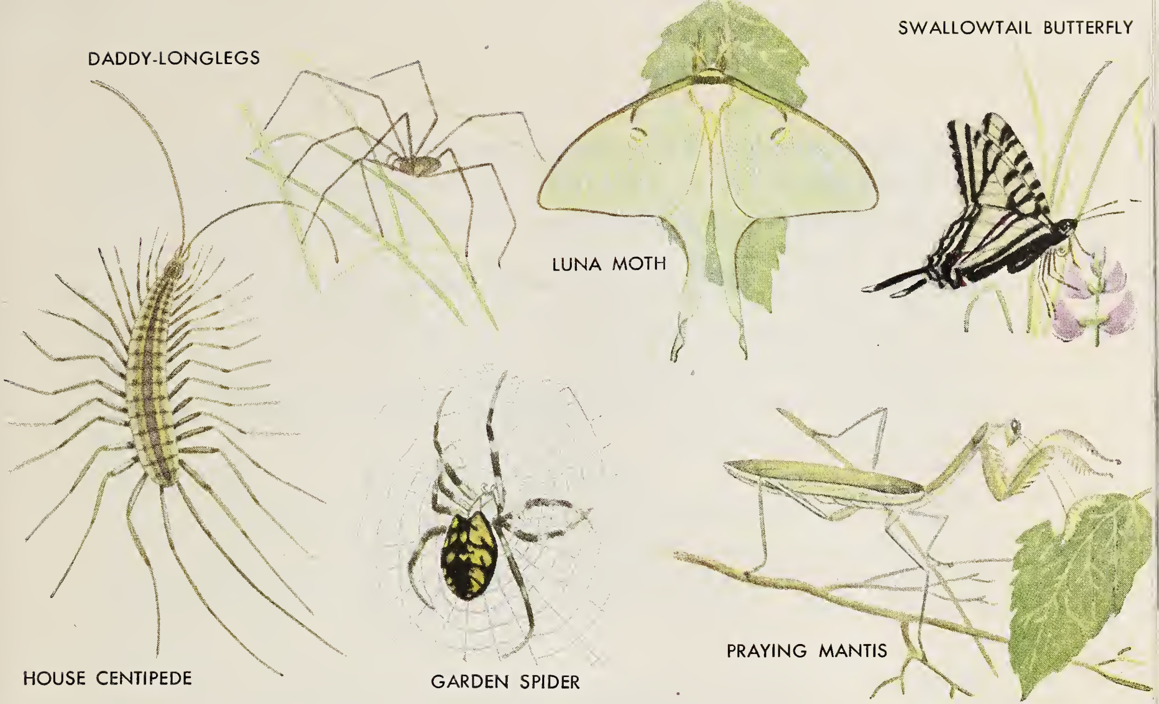
An insect's feeler has a name, too. It is called an *antenna.* When we talk about two feelers, we say *antennae.*

The structure of these six-legged animals that the class was studying is quite different from the structure of the other animals they had studied. The body of every insect is divided into three parts. Ants plainly show these three parts. Some insects, though, have the head and middle part closely joined together. You would need to use a magnifying glass to see the three parts.

The legs of all insects are fastened to the thorax. If the insect has wings, they are fastened to the thorax, too.

One of the most interesting things about insects is that they have no bones. Mammals, birds, reptiles, amphibians, and fish have a *skeleton* of bones on the inside of their bodies. This is a framework that helps hold the soft parts of the body together and gives an animal its shape.

Insects have a covering on the outside of their bodies. This covering takes the place of the skeleton of bones that mammals and many other animals have. On some insects the covering is almost as hard as your fingernails. On others it is very thin. Beetles have a very hard covering on their bodies. A mosquito's covering is much thinner.



You can hunt for some of these animals in your own back yard or in the park.

Henry had been holding a grasshopper under a magnifying glass. At last, he said, "What is this little row of dots along the sides of the grasshopper?"

"Those little dots are breathing holes," said the teacher. "The grasshopper gets air through them. All insects breathe in this way. Mammals breathe with lungs. So do birds, reptiles, and amphibians. Fish breathe with gills. But insects get air into their bodies through the many breathing holes along the sides of their bodies."

Then the class named the ways all insects are alike.

1. Insects have six legs.
2. Insects have two feelers.
3. Insects have a body that is divided into three parts.
4. Insects have a covering on the outside of their bodies.
5. Insects breathe through breathing holes along the sides of their bodies.

Read over this list of the ways in which all insects are alike and look at the pictures on this page. Are all of these animals insects? You are probably surprised to find out that the spider and the daddy-longlegs cannot be put with the insects. As you can see, a spider and a daddy-longlegs have more than six legs. Their bodies are divided into two parts. They belong in another group of animals. Do you think a centipede is an insect? Or do you think it belongs in another group, too?

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1. *Name five ways in which all insects are alike.*
2. *How do insects breathe?*
3. *Which of these ways did the boys and girls use to find the answers to their questions?*

   Thinking *Reading* *Asking* *Watching*
4. *Use each of these ways to find out if a bee is an insect.*
5. *Why is a spider not put into the insect group?*
6. *Name all the insects you can think of that live near your school.*

Are there other groups of animals?

The children had learned that a spider is not an insect because a spider has eight legs and its body is divided into two parts. But the spider did not belong in any of the other animal groups the children had learned about.

The children looked again at their science shelf. They found that there were still several animals that they

SNAIL

CRAYFISH

had not put into any group. The snail and the clam and the crayfish did not belong in any of the groups they had named.

Two of the children had been to the seashore. They had brought back some starfish and a prickly animal called a sea urchin. These did not fit into any of the animal groups. There were also some earthworms that had not been put in any group of animals.

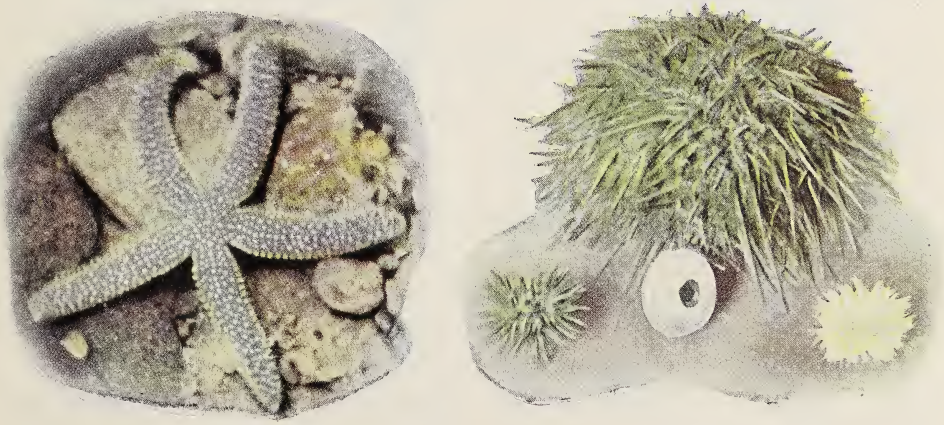
"Where shall we put all these other animals?" asked Nancy.

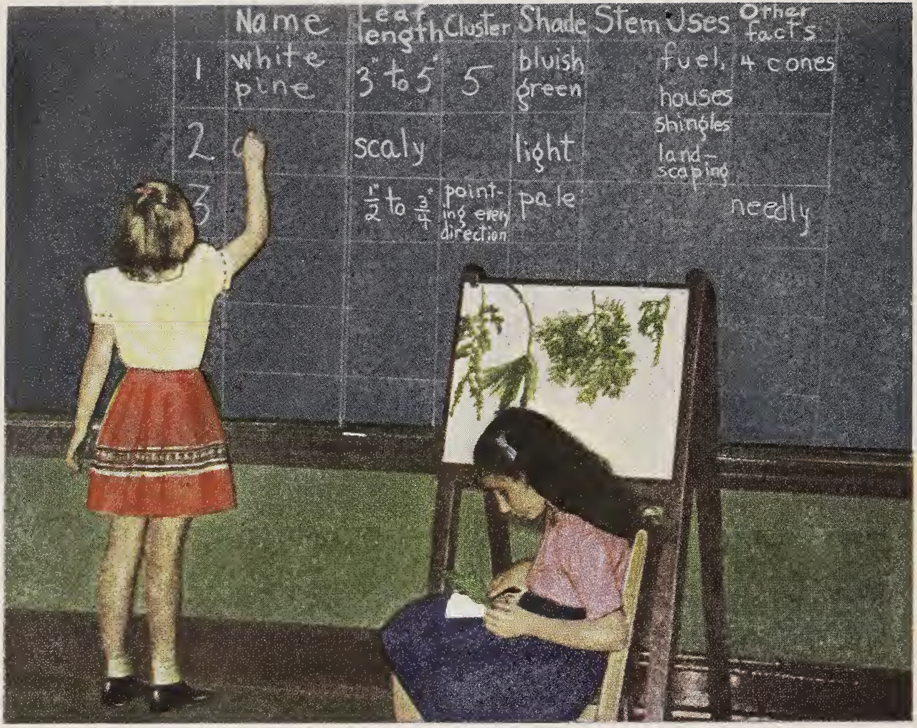
"That is a good question," replied the teacher. "There are other groups of animals you have not learned about. These other groups of animals are all alike in one important way. They have no skeleton of bones inside their bodies. The animals you are wondering about belong in these other groups of animals. You will learn the names of these other groups and more about them later on in your science work. Mammals, birds, fish, reptiles, amphibians, and insects are the most common groups of animals. Suppose we put all the other animals together and just call them other animal groups."

At last, the class had put all the animals into groups. They made a sign for each group.

MAMMALS FISH AMPHIBIANS
BIRDS REPTILES INSECTS
OTHER ANIMAL GROUPS

The animal in the left-hand picture is a starfish. The other picture shows a sea urchin. The children in the picture on page 6 will probably find animals like these in the pools among the rocks.





These children are learning about some evergreen trees by studying their parts and describing how they look.

What are the two big groups of plants?

Now all the animals on the science shelf were separated into groups. But the plants were all together just as the children had placed them. What would you do if someone asked you to put a lot of different plants in groups?

"Plants are different from each other," said Betty. "We can look at them and see how they are made. We can do the same things that helped us put our animals into groups."

"Yes," said the teacher, "let us study the plants carefully. Perhaps we can find some differences in structure that will help us put them in groups. Of course, you know that plants are not covered with feathers or fur. And they do not have arms or legs or wings or eyes. But they do have parts, just as animals have parts. Structure, you know, means the parts of anything and the way they are put together."

The teacher showed the class a snapdragon plant she had pulled up from her garden that morning.

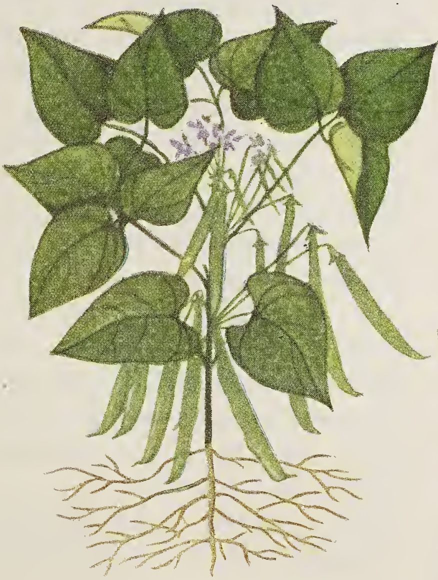
The boys and girls pointed out some of its parts. They found the *roots*, the *stems*, the *leaves*, and the *flowers*. Which of these parts can you find in the picture of the bean plant?

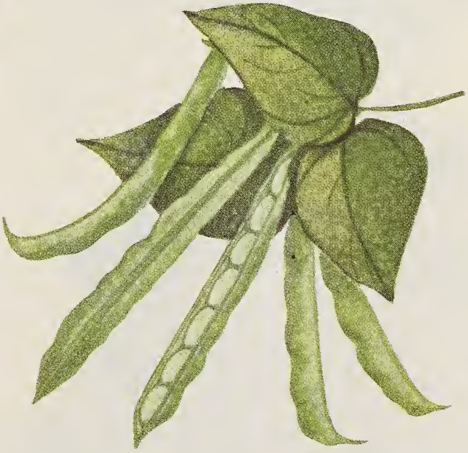
There was one other part of the plant that the boys and girls were not sure about. This part was brown, and it seemed to be some kind of *pod*. Mary was sure it had come from a flower. It grew on the plant in the place where the flower had been. The class opened the pod, and they found little black seeds inside.

Then the teacher explained that every kind of plant that has flowers also has seeds. The seeds are formed inside the flower. The flower withers away, and the seeds are left to fall to the ground and grow into new plants.

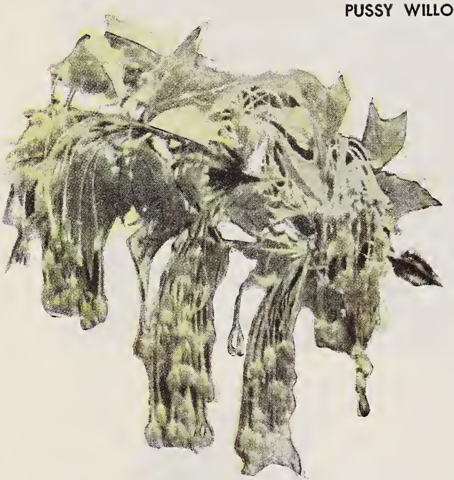
"This afternoon when you get home," she said, "look for some flowers that have made seeds and bring the plants to school tomorrow."

Billy brought a bean plant from his father's garden. He showed it to the class and said, "You can see the roots, the stem, the leaves, a flower, and a bean pod. The seeds are the beans inside the bean pod. And here is a tiny bean pod that is just starting to grow from the flower."





PUSSY WILLOW



MAPLE

APPLE

The next day Nancy brought a sunflower that had many seeds in it. All the children looked at the flower carefully.

"Do all plants have seeds?" Henry asked.

"No," answered the teacher, "some plants do not have seeds."

The answer to the question showed the class the first thing to do in putting the plants in groups. They had to divide their plants into two big groups. So their teacher helped them divide all their plants into these two groups.

1. Plants that have seeds.
2. Plants that do not have seeds.

As soon as the class had done this, they began to name some of the plants they knew that grow from seeds. They named sweet peas, petunias, peas, beans, asters, pansies, and many others in their gardens.

Perhaps you think that flowers are always large, with bright colors. But when a scientist uses the word *flower,* he means the part of a plant that grows seeds.

Maple trees have flowers. So do beech, hickory, and walnut trees. Their flowers are small, and you probably have never noticed them. You eat the seeds of some of these trees, but you call them nuts.

"You certainly can see the flowers on apple trees and horse-chestnut trees and locust trees," said Nancy. "And you can smell them, too."

"Then grass must have flowers, too," said Henry. "We planted grass seed in our yard this spring."

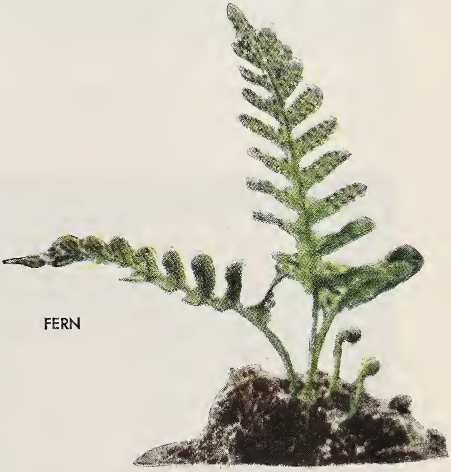
Henry was right. Grass has flowers, too, but they are so tiny you probably have never seen them. Corn tassels are really flowers, and the tops of wheat plants have tiny flowers.

"Now let us learn about plants that have no flowers and no seeds," said the teacher. "First, let's look at Betty's fern. Did you ever see flowers on a fern? I'm sure you never did, for a fern does not have either flowers or seeds."

Then she showed the class the underside of a fern leaf. There were rows of little yellow-brown dots on it, just like the ones in the picture on this page. The class studied the dots on the fern leaf carefully. They found that they could break the dots open. When the dots were broken open, something that looked like brown dust came out. The teacher told the children that each tiny bit of this dust could grow into a new plant.

The children knew that seeds grow into new plants. But they said that the bits of brown dust did not look at all like the apple seeds, bean seeds, and other seeds they had seen. And they were right. The bits of dust are not seeds. They are called *spores*.

BLACK WALNUT


FERN

PUFFBALLS

"This mushroom doesn't have any flowers or seeds," said Betty, after she had looked at it carefully. "Are there other kinds of plants that have spores instead of seeds?"

"Yes," answered the teacher, "if you crush one of these puffballs, you will see many spores. A puffball is a kind of mushroom, too. Puffballs and other mushrooms belong in the group of plants that grow from spores instead of seeds."

The boys and girls then looked at some moss. They saw many small plants growing very close together.

"These plants are very tiny, and they don't seem to have leaves and stems," Nancy said. "Moss plants have no flowers or seeds, have they?"

This beautiful mushroom is very poisonous. People who gather mushrooms to eat must know just which ones to pick.

"No," answered the teacher, "moss plants have no leaves and stems. And they have no flowers or seeds. They grow from spores, too."

The class learned that puffballs and other mushrooms, mosses, and ferns have no flowers or seeds. But they found out that all of these plants have spores.

Then the children looked at some seaweeds that they had brought from the seashore. Mary said, "We saw lots of seaweeds growing on the rocks and in the water. But we didn't see any flowers or seeds on them."

"Seaweeds belong to the group of plants that do not have flowers or seeds," explained the teacher. "Like ferns, mosses, and mushrooms, they have spores instead of seeds."

Now the boys and girls were ready to separate their collection of plants into two groups on the science shelf. The children made two signs.

HAVE FLOWERS AND SEEDS

HAVE NO FLOWERS AND NO SEEDS

They had very little trouble separating the plants until they came to the cone from a pine tree. They did not know whether pine trees grew from seeds. While Peggy was handling the cone, some seeds fell out of it. Then the children learned that this cone was the part of the pine tree that grew seeds. If the seeds are

The green pine cones are still growing, and the seeds are growing inside them. The brown ones have opened and dropped their seeds to the ground.

planted, little pine trees will grow from them.

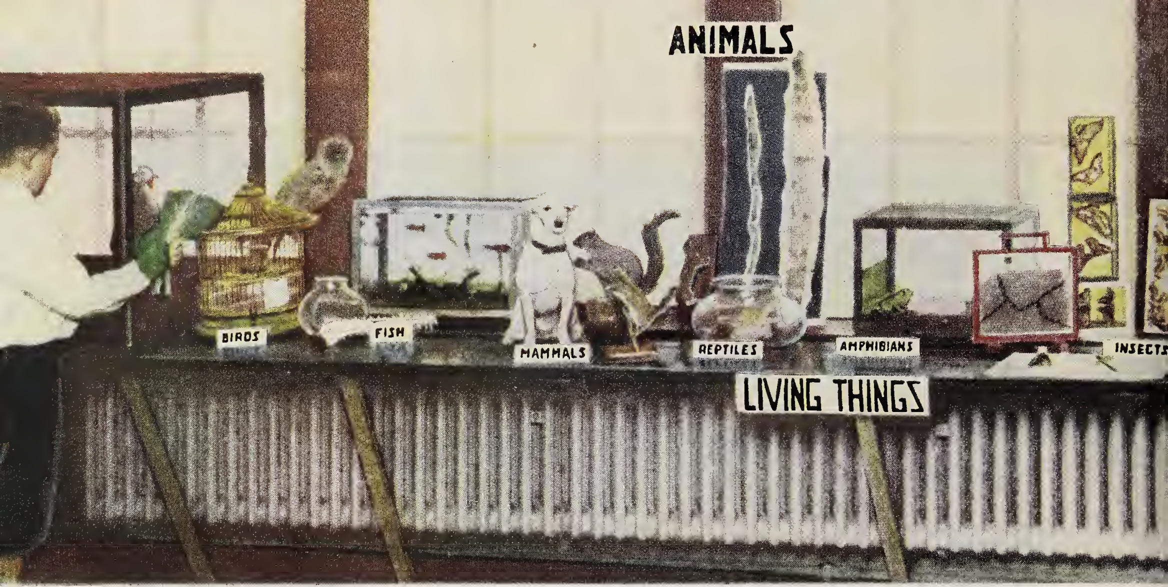
All the plants with seeds are divided into two groups. One group grows its seeds in flowers. The other group grows its seeds in cones. Pines, spruces, firs, and hemlocks are trees that grow their seeds in cones.

---

1. *Which groups of words below tell you something about the structure of a plant?*

   a) Grows in the water
   b) Has red flowers
   c) Needs plenty of sunlight
   d) Lives only one year
   e) Has roots, stems, and leaves
   f) Has a short, thick root
   g) Is good to eat
   h) Has big, thick leaves
   i) Has seeds and flowers
   j) Has spores

2. *In what parts of plants do the seeds grow?*
3. *Make a list of all the plants named in pages 38-43. Then divide them into two groups: Plants with Seeds and Plants without Seeds.*



This is the way the science shelf looked when the class had finished putting all the things in the groups to which they belong.

QUESTIONS TO ANSWER

1. Suppose you had a collection of different kinds of buttons. How would you go about putting them into groups?

2. What do scientists do when they put things into groups?

3. How are insects different from the other animals you have studied?

4. If you found an insect that had wings, would it be correct to say that all insects have wings? Explain your answer.

5. If you found an animal in the woods and wanted to know in what group it belonged, how would you find out?

6. First, separate the things in the next column into *Living Things* and *Non-Living Things*. Then write the names of the plant groups and animal groups you have studied and put each living thing in the group where it belongs.

Mouse
Nail
Cricket
Toad
Geranium
Mushroom
Rock
Bottle
Moss
Snake
Sunfish
Penguin
Ant
Fox
Peach tree
Turkey
Sheep
Pen point
Duck
Paper clip
Grasshopper
Salmon
Alligator
Frog
Pine tree
Dandelion
Orange
Oak tree

THINGS TO DO

1. Study the animals in a zoo and try to tell what group each animal belongs in.

2. Make a picture zoo. Gather all the pictures of animals that you can find and separate them into groups. Get a scrapbook and paste the pictures in by groups.

3. Find two plants that you can bring to school. Try to get plants that are very different from each other. Be ready to tell everything you can about the structure of each plant. Show how the plants are alike and how they are different.

4. Make these signs and put each one at the top of a large piece of cardboard—Mammals, Birds, Fish, Reptiles, Amphibians, Insects, Plants with Seeds, and Plants without Seeds. Find pictures of animals and plants in magazines. Paste each picture on the correct piece of cardboard. Explain how you decided in which group each plant or animal belongs.

5. Take a walk around the neighborhood. Make a list of all the living things you see. Then separate them into their right groups.

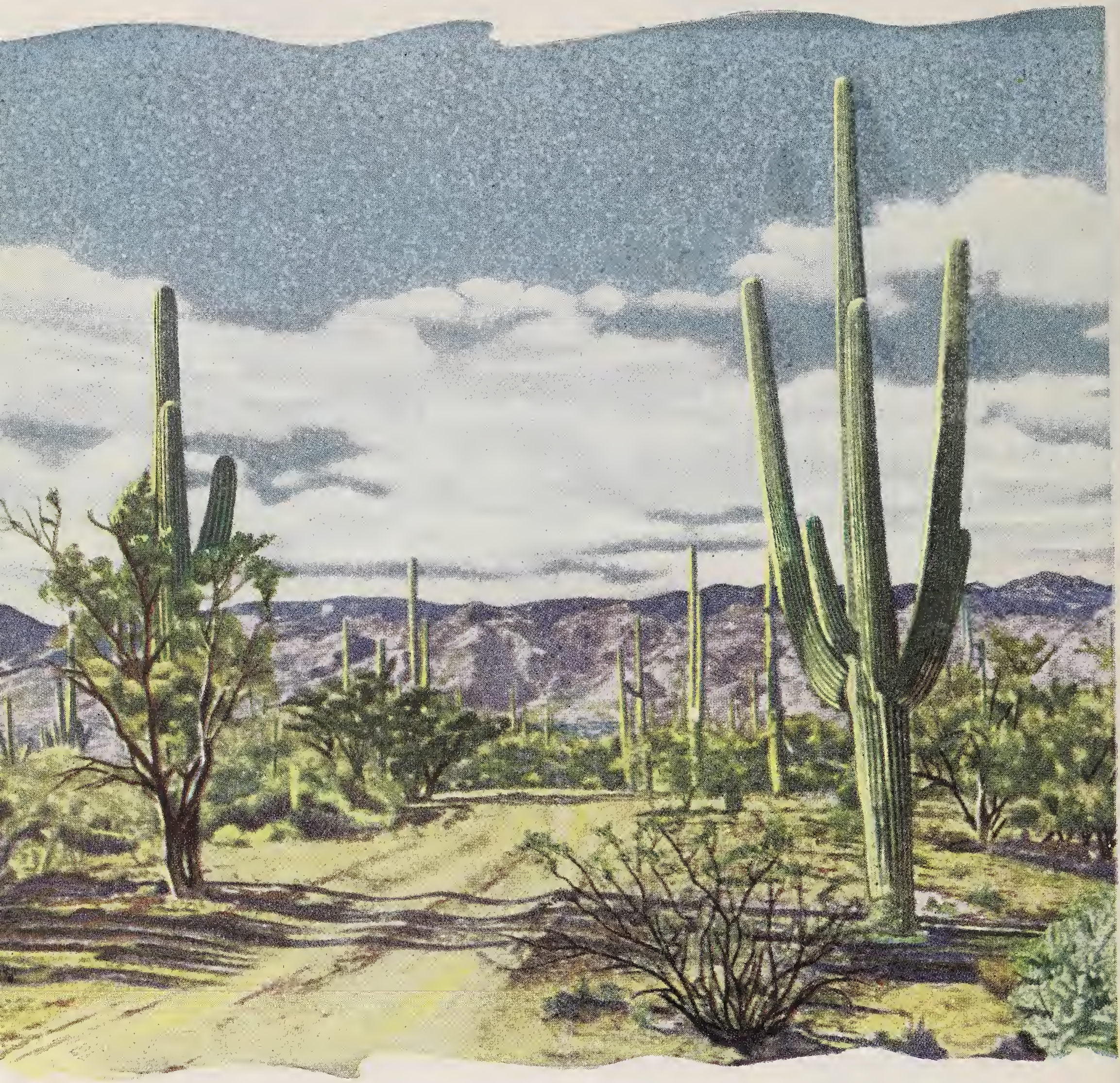
6. Make large charts that tell the important things about each group of animals and plants that you have studied. Put pictures on the charts.

7. If you live near the seashore, make a collection of seaweeds. Find out how to mount them on cards.

8. Find out whether a bat is a mammal or a bird.

9. Read about snakes in books or magazines. Find out how snakes often help people.

10. Find out if a whale is a fish.



★ In Unit Two You Will Learn ★

★ What air is ★ Where air is found ★
★ What part of the air animals need ★
★ How plants get and use air ★ Where water is found ★
★ Why plants and animals need water ★

★ UNIT 2 ★

Why Do All Living Things Need Air and Water?

One summer John went on an automobile trip with his father and mother. They drove through a part of our country that was very strange to them. For miles and miles there was hardly a living thing. They saw only a few low bushes. Once in a while they saw a bird.

"Why don't more things live here?" John asked.

"Because there isn't enough water," answered his father. "Rain falls only a few times a year, and the sun is so hot that the ground dries up quickly. There are many other places in the world where there is almost no water. These places are called *deserts*. Very few kinds of plants and animals can live in deserts."

John thought that he could understand why living things need water. There was no drinking water in the car and none along the road. He was so thirsty that he could hardly stand it. And he felt as if he were drying up.

If you have some plants and animals at school or at home, you know that water is one of the things they need. Plants and animals need food, too. Every living thing in the world must have water and food.

But water and food are not enough to keep living things alive. Something else is needed. When you are in swimming, can you stay under water very long? Why? What would happen to grasshoppers if you kept them in a small glass jar with the top screwed on tight? You might put in plenty of food and water, but even then they could not live. They must have another very important thing. Do you know what it is? It is air. Every living thing must have air.

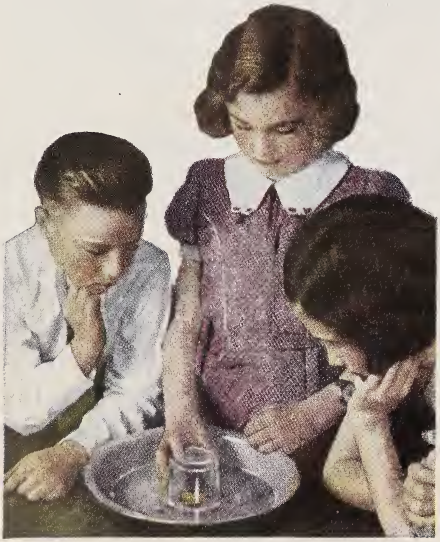
You could live about three days without water, but you could live only seven minutes without air. Divers who work deep under water and aviators who fly very high above the earth must have special supplies of air.

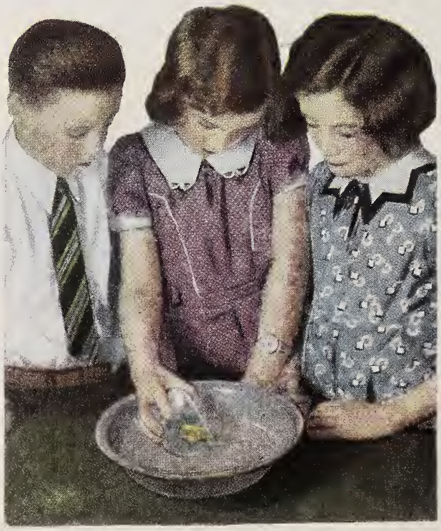
What is air?

We cannot see air. We cannot smell it, either. And we cannot cut off a piece of air with a knife. Yet air is just as real as anything that you can see and cut. You can prove that air really is something by doing an experiment with a glass.

The glass probably looks empty to you. But is it? If you think it really is empty, do this. Pour three or four inches of water into a deep pan. Put a cork or chip of wood on the water to help you see what happens. Then turn the glass upside down over the cork or chip. Push the glass straight down into the water to the bottom of the pan. Does the water go up into the glass?

Something is keeping the water out of the glass. Tip the glass slowly to one side. Do some big bubbles suddenly come out of the glass and up through the water? Does some water then go into the glass? The bubbles are air. Air has to come out of the glass before water can go in. This





shows you that air takes up room. It takes up room in the same way that rocks and wood and iron take up room.

Even though we cannot cut off a piece of air and wrap it up, still we can fill a paper bag with air. Get a paper bag and blow into it as the boy in the picture is doing. What makes the bag swell out? Feel the bag. Does this show you that air is something?

But air is not like wood, stone, iron, and glass. Wood, stone, iron, and glass are all called *solids*. Solids cannot be poured like water. They keep their shapes. Water is not a solid. Water is a *liquid*. Gasoline, milk, and oil are also liquids.

Air is not a solid, and it is not a liquid. Air is a *gas*. Every material in the world is a solid or a liquid or a gas. Sometimes the same material can be a solid, a liquid, or a gas. Water is a liquid. But when water is frozen into ice, it is changed to a solid. And if water is heated enough, it will change to a gas we call steam.

You have seen many liquids and solids, but did you ever see a gas? Some kinds of gases can be seen easily because they have color. Some are blue, some are yellow, and some are green. Other gases have no color. You can smell some kinds of gases, but some other kinds you cannot smell. Can you smell or see the gas from a gas stove when you first turn it on?

The air you breathe is not just one kind of gas. It is made up of several different kinds of gases. These gases are all mixed together. So we say that air is a mixture of gases. Some of the gases in air are very important to living things. Let us see what the two most important ones are.

One of the gases in the air is called *oxygen*. No one has ever seen oxygen, because it has no color. No one has ever smelled oxygen, either, because it has no smell. But it is in the air just the same. You will soon learn how very important oxygen is to living things.

There is a much smaller amount of another important gas in the air. It is called *carbon dioxide.* Later, when you study more about plants, you will learn how plants use carbon dioxide. There are several other gases in the air, but you do not need to know about them now.

---

1. *Name three things that plants and animals need to grow and stay alive.*
2. *Tell about two experiments that you can do to show that air really is something even though we cannot see it.*
3. *Name a solid that is in your schoolroom. Is there a liquid in your room? Is there a gas? Can you find something in your room that is not a solid or a liquid or a gas?*
4. *What two important gases are in air?*
5. *How can a liquid such as water be changed to a solid? How can it be changed to a gas? How can a solid be changed to a liquid?*
6. *How can you tell the difference between a solid and a liquid?*

Where is air found?

YOU ARE REALLY living at the bottom of an ocean of air, because the earth is covered with a great layer of air. You walk around on the bottom of this ocean, and you push the air aside as you walk. How high above the earth do you think the air really goes? It goes up more than 500 miles. But most of the air is near the earth. High up above the earth the air is very thin.

You are looking through air when you look at this page. Air is all around you. If you wave a piece of paper in the air, you can feel air pushing against it. There is air in your clothes. Hold up one thickness of cloth very near an electric-light bulb or toward a window. You can see the hundreds of little spaces in the cloth. Air crowds into these spaces. It crowds into every crack and corner of the earth.

You already know that there is air in water. Fish could not live in water if it had no air in it for them to breathe. Plants that grow entirely under the water must have air, too.

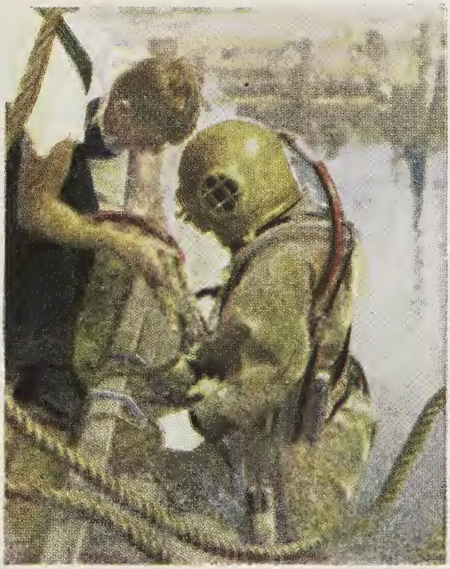
You can do an easy experiment that will show you that there is air in water. Heat a pan of water on a stove and watch the water carefully

The frogs must come up to the surface of the water for air.

while it heats. What do you see on the bottom and sides of the pan as the water heats? These are bubbles of air coming out of the water.

You may be surprised to learn that air is found in still another place. Drop a lump of soil into a glass of water and watch it closely. What do you see coming from the soil? These are bubbles of air.

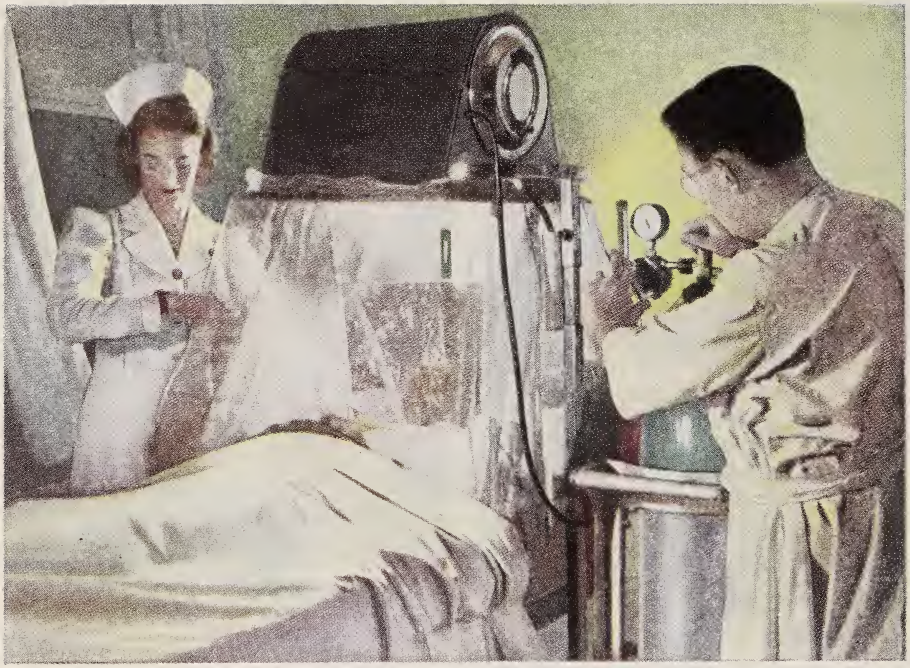
Earthworms, moles, and other animals that live in the ground must have air to breathe. After a heavy rain, you will often find many earthworms on top of the ground. The rain water has filled up the spaces between the bits of soil. So the earthworms have to come out on top of the ground to get air. As the water sinks down deeper into the soil, the air goes back into the spaces. Then the earthworms go back into the soil.



The diver has air sent down to him through the tubes that lead to his helmet.

---

1. *Name three places where air is found.*
2. *In what ways can you show that there is air in the three places you named?*
3. *Is there any air inside your body? How do you know?*
4. *Why do you have to take deeper breaths of air if you are up on a high mountain?*



The doctor is giving this girl some oxygen from the large green tank. This will help her breathe more easily.

What part of the air do animals need?

Once long ago a scientist was much interested in finding out how living things use air. He had just discovered that air is a mixture of gases. Up to that time everyone thought that air was just one kind of gas. This scientist wanted to know whether animals needed all of the air or just a part of it. Almost everyone knew that living things need air, but they did not know why.

One day the scientist thought of this experiment. He took a glass jar that could be made airtight. Then he caught a mouse and put it inside the glass jar. He closed the jar so tightly that no fresh air could get in. What do you think happened?

At first, the mouse ran around and jumped up the sides of the glass jar. But soon it began to get tired. It moved about more slowly. It did not try to climb the sides of the jar. At last, it seemed to be quite sleepy and did not move around at all.

"Now," the scientist thought, "perhaps the mouse has used up just one kind of gas that is in the air. I'll see if it is the oxygen that the mouse has used. I'll pump some oxygen into the glass jar, and I'll not put in any other gas."

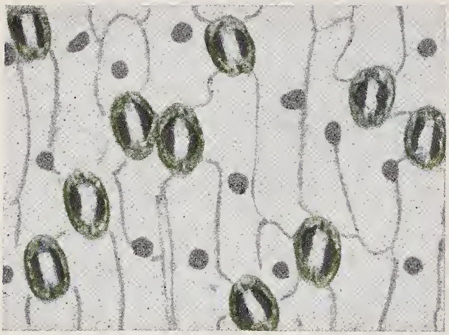
The scientist began to pump oxygen slowly into the jar. What do you think the mouse did? It began to jump and run around again. It acted as lively as when it was first put into the jar. The scientist tried the same experiment with other animals. He found that they could live as long as there was oxygen. When the oxygen was used up, they died if he did not give them more. In this way the scientist found out that animals must have oxygen from the air if they are to stay alive.

Right now, as you read this, you are breathing. Have you ever stopped to think that you breathe air all day long and all night long? When you breathe, oxygen along with the other gases in the air goes into your lungs. When the mixture is breathed out again, some of the oxygen is left inside your body. What do you think the oxygen does for you? Why must you have oxygen to live?

To keep alive, your body must be warm. The heat to keep you warm is made when the food you eat and the oxygen you breathe join in your body. Oxygen joins with food in your muscles. This must happen before your muscles can make your body move. Not one part of your body could move without oxygen. Even your heart would stop beating. Now do you understand why you must always have a good supply of the oxygen that is in the air?

---

1. *What was the scientist trying to find out about air and living things?*
2. *What did the scientist do to find out whether oxygen was a part of the air needed by animals?*
3. *What did scientists have to discover before they could find out how living things use air?*
4. *Why should we sometimes change the water in a fish bowl?*
5. *Does the air you breathe out have as much oxygen in it as the air you breathe in?*
6. *Why do animals need oxygen?*



If you could look at a leaf with a microscope, you would see the tiny openings.

The floating leaves of water lilies have openings only on their upper sides.

How do plants get and use air?

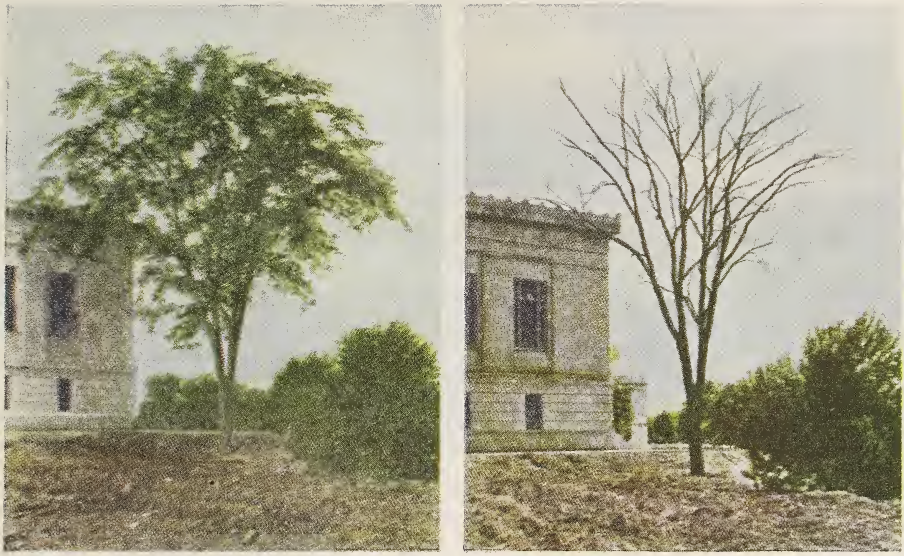
PLANTS, TOO, need air. Do you know how they get it? If you could look at the upper and lower sides of a leaf with a microscope, you would find many tiny openings. In most plants there are more of them on the underside of the leaf than there are on the upper side. Now let us find out just how important these little openings are to plants.

Get two small potted plants of the same kind. Spread some vaseline on both the upper and the lower sides of all the leaves of one of the plants. This will fill up the openings. Watch the plants and see what happens. It may be some time before any change takes place. Do the leaves get yellow and drop off the plant that has the vaseline on its leaves? Does this plant finally die? Do you know why?

Air goes into the leaves through these openings. If these openings are filled up, the plant cannot get air. And if it does not get air, it dies. Plants must have air just as animals must have air.

In summer, the openings in leaves of plants along the side of a dusty road sometimes get filled up with dust. In cities, where dirt and dust from many factories cover the leaves, it is very hard to grow plants. The dust and dirt fill the tiny openings in the leaf and keep out the air. Of course, if a plant cannot breathe, it will soon die. That is why people sometimes put some of the house plants in the sink or bathtub and wash their leaves.

Now let us see what plants do with the air that goes in through the tiny



The roots of plants must have air, too. This beautiful elm tree died because so much heavy soil was put over the roots. The roots could not get enough air.

openings in the leaves. Plants need the oxygen in the air that they take in just as animals do. As you know, plants must have food to stay alive and grow. Without oxygen, plants cannot use food.

But there is another gas in the air that green plants must have. This gas is carbon dioxide. Plants use carbon dioxide to make food. Animals do not make their own food, but green plants do. Later in your study of science, you will learn more about how green plants use carbon dioxide from the air to make food. So you see that green plants need two gases that are in the air. These gases are oxygen and carbon dioxide.

---

1. *In the experiment, the leaves of one plant were covered with vaseline. No vaseline was put on the leaves of the other plant. Why were two plants used in the experiment?*
2. *Can you find anything in this list of things that does not need oxygen?*
   Cat Tree Stone Insect Fish Dead tree Bird
3. *Why do plants need oxygen? Why do they need carbon dioxide?*

Most maps cannot show all the ponds, rivers, and lakes. But you could see how many there are if you could look down on the earth from an airplane.

Where is water found?

THERE WAS PLENTY of air in the desert that John and his father and mother saw on their automobile trip. Plants could get all the oxygen and carbon dioxide they needed. Animals had plenty of oxygen. Yet very few plants and animals could live in the desert where there was only a little water.

Every living thing must have water. So it is a good thing that water is found almost everywhere on earth. The water in oceans, seas, lakes, and rivers covers about three fourths of all the earth. Get a map of the world and look at the places that are colored blue. They are the oceans, lakes, and seas. You can see that they cover much more of the earth than the land does.

But not all of the water is in oceans, seas, lakes, and rivers. Some of it is in the ground. When it rains, much water soaks down into the earth. We use this water that soaks down into the earth. We dig wells and put pipes down into the earth so that we can pump the water up.

This story tells you another place where water is found.

Jane's mother had promised to take her to the park for a picnic with her friends. On the day of the picnic Jane said, "Oh, Mother! It rained last night. The grass and trees are very wet. We can't have our picnic."

But Jane's mother looked at the sky and said, "All the clouds have gone, and the sun is shining. By afternoon the leaves of the trees, the grass, and even the swings in the park will all be dry."

When it was time for the picnic, Jane found that her mother was right. Do you know where the water had gone? Where does the water go when the wet clothes on the clothesline dry? You can tell if you do this experiment.

Pour water into a glass. Put a rubber band or a string around the glass. Have it even with the top of the water to show just how much water there is in the glass. Make a sign saying "Please do not touch," and set it by the glass. Look at the water in the glass every day. What is happening to the water? Where do you think the water is going?

Does all the water in the glass finally disappear? When water slowly disappears into the air, we say that it *evaporates*. The water changes from a liquid to a gas and mixes with the other gases in the air. When water has turned into a gas in this way, we call it *water vapor*.

Water is always evaporating from places on the earth. Water evaporates from wet ground and from wet trees. Water is always going into the air from lakes, oceans, rivers, and creeks.

There is always some water vapor in the air. There really is water vapor between your eyes and the page of this book. But you cannot see the water vapor.

Perhaps you are wondering whether this water ever gets out of the air again. Here is an easy way to find out. First, be sure that your hands are dry. Then take a dry metal cup and fill it with very cold water or ice that has been chopped into small pieces. Stir the ice and watch the outside of the tin cup. What do you see on the outside of the cup? Where does this water come from?

Can it come from the inside of the cup? Why?

If you used a good metal cup, there were no holes in it. So the water from the melted ice could not get through to the outside. If your hands were dry, the water could not have come from them. There is only one place where the water could have come from. It had to come from the air around the outside of the cup. Let us see why this happens.

Cold air can hold less water than warm air. The ice in the cup made the cup cold. The air that touched the outside of the cup became cooler. Some of the water vapor in the air changed to a liquid and came out of the air. Little drops of water gathered on the outside of the cup. We say that the water vapor *condensed* on the cup. Condense means change from a gas to a liquid.

Have you ever watched water come out of the air? Of course you have. Rain is water condensed from the water vapor in the air. Hail and sleet are frozen rain. Snow comes from water vapor that has frozen in the air. Dew and frost also come from water vapor in the air. Rain, hail, sleet, snow, dew, and frost all come from condensed water vapor.

Water is always going into the air from the lakes, rivers, oceans, ponds, and puddles. Can you imagine what would happen if this water could not come out of the air again? We would soon have no more water on the earth. We have plenty of water because the water vapor in the air can condense to make rain or snow.

---

1. *What are the missing words in the statements below?*
    a) *When water goes into the air, we say it* _____.
    b) *Water changes to* _____ _____ *when it goes into the air.*
    c) *When water vapor comes out of the air, we say it* _____.
2. *Where is water found? Write your answer to this question and read it to the class.*
3. *Should you heat air or cool it to make the water vapor in it condense? How do you know?*
4. *What happens on the outside of a pitcher of ice water or ice-cold lemonade when it is brought into a room on a hot summer day? Why does this happen?*
5. *A boy wearing eyeglasses on a cold winter day came into a warm room. His glasses clouded up so that he could not see through them. Why did this happen?*

In parts of our country where there is not much rain, trees can grow only along the banks of streams. The next three pages will help you understand why this is true.

Why must plants have water?

Do you know why plants must have water? There is something very wonderful that water and other liquids can do. Let us find out what it is. Then we can understand why plants need water.

Suppose someone asked you to pass some sugar through a cloth without tearing the cloth. How would you do it? Perhaps you think you could not do it, but try this experiment. Drop some sugar into a glass of water. Stir the water until you can no longer see the sugar. Taste the water. Where is the sugar?

The sugar is in the water. Scientists say that the water *dissolves* the sugar. Water is the world's best dissolver. It can dissolve more things than any other liquid can. Now pour the water through the cloth. Taste the water again. Did the sugar go through the cloth?

When the sugar is dissolved, it can pass through the cloth. You can do the same thing with some salt. Try it and see if this is true.

Now let us see how water helps plants because it can dissolve so many materials.

Perhaps you have watched someone spread *fertilizer* on a lawn. The fertilizer is made up of materials that the grass needs for making food. But if it is left on top of the ground, the fertilizer does not help the grass grow. So the person who is spreading the fertilizer, waters the lawn. Or he waits for the rain to fall.

The water that falls on the lawn dissolves the fertilizer. Then the water with the dissolved fertilizer soaks into the ground. When it soaks down where the roots of the grass are, the roots begin to take in the water. The dissolved fertilizer goes into the roots with the water.

Now you can understand why plants need water. The materials that plants need to make food are in the soil. But these materials have to be dissolved in water before they can soak into the plant roots. Plants could never get the materials from the soil if the water did not bring them in. Plants could not live in the best soil in the world if they did not have water.

Let us see if we can find another way in which water helps plants. Put some red ink in a glass of water. Then put a stalk of celery that has some leaves on it into the red water. Watch the celery for a while. How long does it take the red water to go up the stalk and into the leaves?

Water is the world's best dissolver. It is also one of the best carriers. It can go from one place to another very easily. As it moves, it carries along the materials that are dissolved in it. The water with the dissolved materials in it soaks into the roots of a plant. Then it travels up the stem to the leaves of the plant. This watery liquid that travels through the plant is called *sap*.

Here is an easy experiment to show you that plants need water to grow. Get a yard or more of white cloth. Fold it several times until it is about the size of a handkerchief. Now sprinkle the cloth with water until it is quite damp. Lay about two dozen bean seeds on the cloth. Then roll it up with the seeds inside. Sprinkle the cloth with water every day so that it will not dry out.

Take another cloth of the same size. Fold it and lay the same number of bean seeds on it. Roll this cloth up just as you did the other one. Do not wet this cloth. Keep both cloths in the same place for a week. Then open them up and look at the seeds. What do you find? Why did something happen to one set of seeds that did not happen to the other set?

The bean seeds have baby plants inside them. The seeds also have food inside them for these tiny plants to use for growing. But the tiny plants cannot use this hard food unless they have water to change and dissolve it. The baby plants in the seeds that were rolled up in the dry cloth could not use the hard food that was around them. But the water from the wet cloth around the other seeds changed and dissolved the food so that the plants could use it for growing. Does this experiment show you why plants need water to grow even when they are inside a seed?

---

1. *Water helps plants in two important ways. What are they?*
2. *How does water help seeds start growing? How could you show that seeds need water to start growing?*
3. *Choose the right word for this sentence. Water* (evaporates—dissolves—condenses) *food for the plant. How do you know that you are right?*
4. *Suppose nothing in the world would dissolve. Would that make any difference to you? Explain your answer.*
5. *Why are rains in the spring very important?*
6. *Write five things you have learned about water and plants.*
7. *Why do you think the trees in the picture on page 59 are growing only along the river banks?*

These animals live in a very dry part of Africa where there is not much water except in small pools or water holes.

Why do animals need water?

Almost every kind of animal in the world must have water just about every day. You could live for a month without food, but you would die in about three days without water. Nearly three fourths of your body is made up of water. If you stopped drinking water long enough, your body would dry up like the leaves and the grass in the hot summer months.

Why do we and other living things need water for our bodies? Water helps our bodies use food. The food we eat has to be dissolved before our bodies can use it. The water we drink helps dissolve the food we eat. You would have a hard time swallowing dry cookies and bread if the *saliva* in your mouth did not moisten them for you. Saliva is one of the body's juices. It is made partly of water.

There are many juices in your body that keep food moist and dissolve it. Your body cannot use dry food any more than a baby plant can use the dry food in a seed. Without water, your body could not make these juices that change food so that we can use it. In the next unit you will learn more about this.

All animals must have water. So many different kinds of animals can often be found around one water hole at the same time.

The blood of animals is made up mostly of water. If animals did not have water to drink, they would not have blood to keep them alive. The blood in your body acts in much the same way that sap in a plant does. It carries food and oxygen around inside your body.

When you eat food, all you need to do is to chew it and swallow it. Then it goes down into your stomach. But it has to go down to your toes and up to your arms and head. Every part of your body needs some of the food. Your blood carries the food to all parts of your body. It carries oxygen, too. Both food and oxygen must be carried to the places in the body where the food is used. Do you see now why someone once said, "Without water, nothing could stay alive on the earth"?

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1. *Make a list of the things you have learned about animals and water.*
2. *Why must your body have water to use food?*
3. *When you are thirsty, how does your mouth feel?*

Can you tell where the frost on the window came from?

QUESTIONS TO ANSWER

1. Why does a person die if he stays under water too long?

2. When aviators fly high above the earth, they need a special supply of oxygen. What does this tell you about the air high above the earth?

3. Which gas in the air helps living things use food? Which gas helps green plants make food?

4. Sometimes hot water looks milky when it comes from the faucet. Can you think of a reason for this?

5. Where does the drinking water in your home come from?

6. About how many glasses of water do you drink in a day? Why is it important for you to drink plenty of water?

7. How does a plant look when it does not have enough water?

8. What happens to a farmer's crops if there is no rain for a long time?

9. Why should you hang up wet clothes if you want them to dry?

10. Why do clothes dry more quickly on a windy day than on a day when there is no wind?

THINGS TO DO

1. Find out how fresh air is kept coming into your schoolroom.

2. Show your class that
   - *a*) There is air in a glass bottle.
   - *b*) A solid can be changed to a liquid.
   - *c*) A liquid can be changed to a gas.
   - *d*) A liquid can be changed to a solid.

3. Learn more about how deep-sea divers get air.

4. Cut open the stalk of celery that you put in red ink and find the parts that are colored. These colored parts carry the water to the leaves.

5. Dig up a dandelion plant and look at the roots. Dig up some grass and look at the roots. Does the dandelion plant have longer roots than the grass? Why can a dandelion plant stay green longer than grass in the dry summer months?

6. Find some green leaves and look for the parts of the leaves that carry water.

7. Find out if there is much water in a peach or in an apple. First, weigh one of these fruits. Heat it for a long time in an oven. Then weigh it again. The heat made the water evaporate from the fruit. Was there much water in the fruit?

8. Find out more about how desert plants can live where there is so little water.

9. Make a list of the new science words you learned in this unit and show the class that you know what each word means.

10. Find out more about oxygen, carbon dioxide, and other gases in air.

⋆ *In Unit Three You Will Learn* ⋆

⋆ How your body is like a machine ⋆ How your bones help you ⋆ How your body can move ⋆ How your body uses the food you eat ⋆ How food is carried to all parts of your body ⋆ ⋆ How your body gets oxygen ⋆ What skin does for your body ⋆ ⋆ How you know what goes on around you ⋆ ⋆ What keeps the parts of your body working together ⋆

⋆ UNIT 3 ⋆

How Does Your Body Work?

When the boys and girls of a science class came into the room one day, they found these sentences on the blackboard.

I am the best machine in the world.

I can lift things.

I can remember things I do.

I can change a glass of milk into part of me.

I can tell if anything comes near me.

I need something to make me go, and I can get it myself.

I can run myself.

I can repair myself.

There are millions of machines like me.

What am I?

It took the boys and girls a few minutes to guess the right answer. Bobby said, "It's not an automobile, because an automobile can't lift things, and it can't repair itself, and it can't tell when anything comes near it."

Henry said, "I never saw a machine that could run itself and repair itself."

Then the teacher smiled and said, "There are thirty of these machines in this room now. They are all running. They can all do the things told in the sentences on the board."

Quickly Helen spoke up, "You mean the boys and girls! We are the machines that can do all of these things."

How is your body like a machine?

The engine of your father's automobile is a machine. It is made of many different parts. There are big parts and little parts. There are parts that move and parts that do not move. All the parts work together to make

the engine run. Your body, too, is made of many parts that work together so that you can do what you want to do. In this way your body is like a machine.

All human machines have parts that are alike. These parts are made up of hundreds of smaller parts. There is the main part of your body called the *trunk*. You have other parts called arms, legs, and head. Inside your head and trunk there are dozens of other parts.

An automobile engine will run if it is supplied with gasoline. Of course, you do not need gasoline to make you move. But you do need food. You have a stomach that needs food three times a day so that you will have strength to move. Your body uses this food very much as the engine uses gasoline. To keep going, both you and the engine must be fed.

To keep going, an engine must be kept in good repair. Its parts must be oiled. Broken parts must be repaired or replaced. If any part does not do its work, the engine will not run properly. Your parts must be kept in good working order, too. A stomach ache, a headache, or a broken bone will keep you from doing your best work. Both your body and the engine must be kept in good condition.

So you see that your body and its parts are in many ways like the engine that runs the automobile. But your body can do many things that an automobile engine cannot do. There is no machine on earth so wonderful as a human body.

Did you ever try to count the different things your body does? Try to remember what it has done since you got out of bed this morning. One part of your body did some work that made you *hear* your mother call you. Many parts of your body worked together so that you could *dress* yourself and *wash* your hands and face. You *felt* your shoes to see whether they were still wet from the day before. Just as you finished washing, you *smelled* some of the good food that your mother was cooking for your breakfast. You *ran* downstairs to eat.

All this time you were using your eyes. You *saw* the sun and all the things around you. You *knew* that this would be a good day for the hike you had planned to take after school. You *tasted* the food you ate for breakfast. You *remembered* to ask your father if you could use his pocketknife. When he answered, you knew what he said.

Count up the different things your body did. You heard sounds, dressed yourself and washed, felt your shoes, smelled food, ran, saw many things, and tasted food. You listened, and you talked. You remembered, and you knew what people were talking about. All of these things you did before you had been out of bed an hour. Can you think of any machine that can do so many different things?

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1. *What does your body use to make it go?*
2. *Why should you know some of the important things about your body?*
3. *Why should you take care of your body even more carefully than of an expensive machine?*
4. *How is your body like a machine? How is it different from a machine?*

How do your bones help you?

Did you ever see or hear of an animal called a *jellyfish?* Just from the name, what do you think a jellyfish looks like? You can probably guess. It is just like a mass of jelly floating in the water. It has no bones in its body. Your body would be almost like that if you did not have a framework of bones to hold up the soft flesh. As you know, this framework is called a skeleton.

You have seen many kinds of bones—chicken bones, fish bones, turkey bones, pig bones, and cow bones. Perhaps when you were out in the woods or fields, you found the skeleton of some animal that had died.

You need a framework just as an umbrella needs its steel ribs and its handle and just as a house needs rafters and beams. The bones of the skeleton make up the framework of your body. How many bones do you think there are in your skeleton? There are over 200! Now let us see what this framework of yours is like.

It is made of long bones and short bones, flat bones and round bones. Some of them are broad and flat. Others are long and narrow. Many are very small. Can you feel some of these bones in your fingers, arms, and legs? All of these bones are part of your skeleton.

Look at the picture on page 71 and find the long row of bones along the back of the skeleton. These bones make up what is called the *backbone*, or *spine*. Your backbone or spine holds your body up just as a pole holds up a tent. But your backbone is also made so that you can bend it.

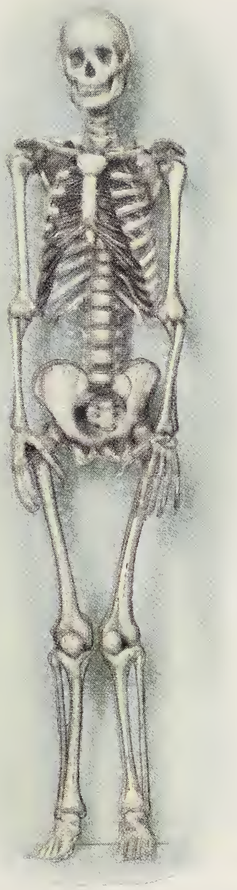
Someone once said that this backbone is like many spools put together on a string. You can see in the picture that it is made up of many small bones. Press your fingers tightly against your backbone. Can you feel the places where the bones come together? Each one of these little bones has a hole through it. These holes make a long, hollow tube through the whole length of the backbone. A white cord, called the *spinal cord*, fills this tube. Later in this unit, you will find out what the spinal cord does.

Between each two bones of your spine there is a soft cushion that acts like a pad. This little cushion keeps the bones from grinding against each other when they move. The cushions are made of *cartilage*. Your ears and nose have cartilage in them, too. When we find cartilage in meat, we call it *gristle*. Tough cords that are called *ligaments* hold the bones of your spine and other parts of your body together. Do you see now why you can bend your back so easily?

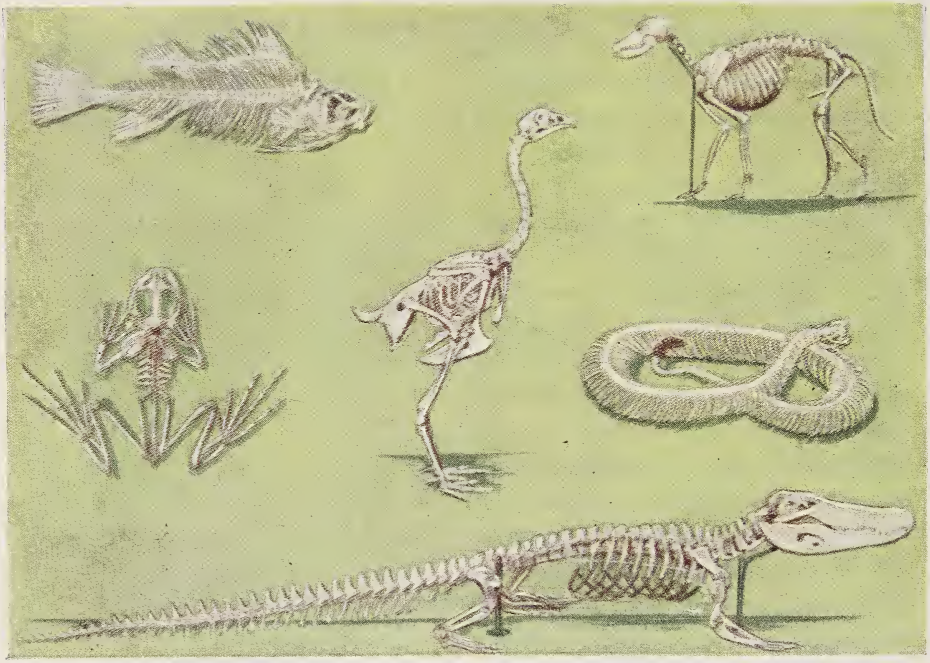
Your backbone is a very important part of your skeleton. It helps hold the rest of your body framework together. It is somewhat like the frame of a bicycle to which the wheels, pedals, and handlebars are attached. Your head, arms, legs, and ribs are attached either to your backbone or to other bones that are attached to your backbone.

Look at the picture on page 72. Do these animal skeletons have backbones, too? Mammals, birds, reptiles, amphibians, and fish are all animals that have backbones.

Bones do more than just support your body and give it shape. You can see what else bones do if you feel the top and sides of your head. Inside your head you have a very tender



brain. Your brain is protected on the outside by a boxlike covering of bones called the *skull*. Sometimes boys find skulls of rabbits or other animals in the woods and bring them to school. It is easy to see that these skulls made a strong cover to protect the brains that once were inside them. Find the skull in the picture of the



Here are the skeletons of some animals. Can you tell what kinds of animals they are from the shapes of their skeletons?

skeleton on page 71. Look at the skeletons of the animals on this page. Do they have skulls, too?

Feel your ribs. Can you feel how close together they are? Perhaps you can count them. There are twelve ribs on each side. Look at the picture on page 71. Can you see how the ribs make a cage that helps keep the heart and lungs from being hurt?

---

1. *Describe the structure of your skeleton.*
2. *What does your backbone do for you?*
3. *How is your spine made so that it can bend easily?*
4. *How do your bones protect you?*
5. *Write down what you have learned about each of these.*
   Skull Skeleton Cartilage Ligaments Backbone
   Read to the class what you have written.

How can your body move?

The boys and girls in the science class were getting ready for a marionette show. Betty was making a marionette farmer. It was the first time she had ever tried to make one. "My Farmer Jim is finished," she said. "But I don't think he will ever move. He is so very stiff."

"You must make joints in his arms and legs so that the parts of his body can move," said the teacher. "You have made his body all in one piece. I'll help you make the joints. Then we will fasten strings to every part of his body that we want to move. I think you will be able to make Farmer Jim walk, run, and even load hay into a wagon if you can work the strings well enough."

Your skeleton would be about as useless as Betty's marionette if all your bones were joined solidly together like the legs, arms, and back of a chair. Of course, the bones must be held together. But most bones must be free to move.

On the next page, are pictures of the bones in the arm and the leg. Find the elbow. Your elbow is the place where the two big bones in your arm are joined together. We call a place like this, a *joint*.

The bones are held together at the joint by ligaments. These ligaments let the bones move, and at the same time they keep the bones from coming apart. Look carefully at the picture of the arm bones. Then try to feel the bones in your own arm. Bend your arm and feel the bones and the joint.

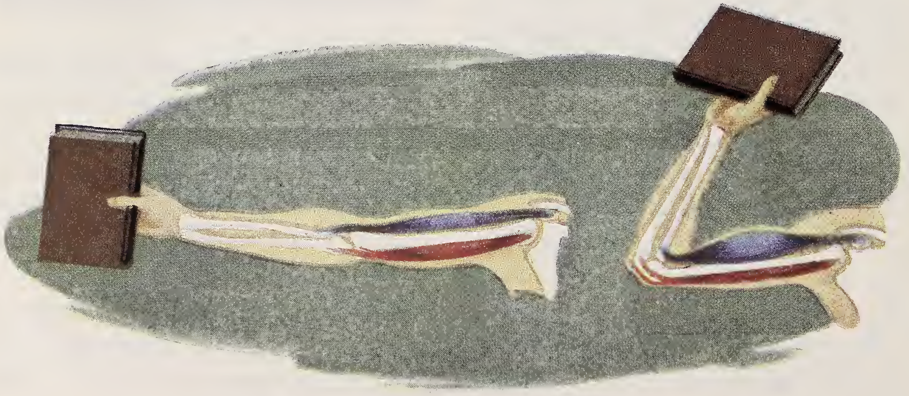
There are joints in your body at every place where the bones can move. You can bend your legs and

toes when you walk because there are joints in both your legs and your toes. Where are the joints that make it possible for you to play a piano or to hold a pencil? Look at the picture of the skeleton on page 71 and find the places where there are joints.

The joints were not able to make Betty's marionette move. You remember how she made it move. To move its arms, she fastened strings to the arms. When she pulled the strings, the arms moved. To move its legs, she fastened strings to them, too. The head could not move, either, until it had a string to move it.

The strings that Betty tied to the parts of her marionette acted much as the movers of your body do. On the next page is a picture that shows the *muscles* of a body. Your muscles are the movers of your body. You can see that there are muscles fastened to the bones. They are fastened so that when the muscles move, the bones must move, too.

An easy way to see how muscles work is to watch them in your arm as you lift a book. Roll your sleeve



up as far as you can. Pick up a heavy book and lift it slowly toward your face. Watch the big muscle in the upper part of your arm. What happens to it when you lift the book? Do you notice that it gets thicker and shorter? Now watch the muscle as you slowly lay the book back on the table. See it get thinner and longer.

If you feel the under part of your arm, you find that there is another muscle there. Look at the picture and find the muscles. In the picture the muscle on top is colored blue. When the muscle on top pulls to lift a book, the muscle gets short and thick. At the same time the muscle on the underside of your arm gets long and thin. When you pull your arm back, the muscle on the underside gets shorter and thicker. The one on the upper side gets longer and thinner.

If you had a muscle only on top of your arm and none on the underside, you could raise your arm. But you could not pull it back. Most muscles work in pairs like the ones in your arm. Now you can see how muscles work to move parts of your body.

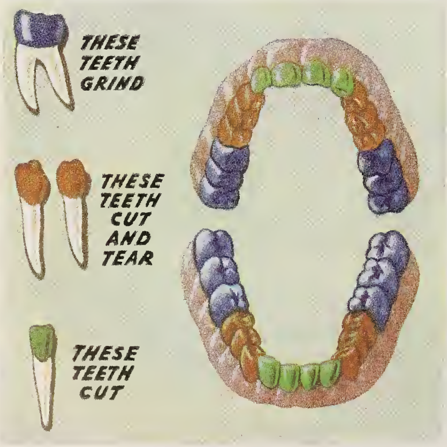
---

1. *Why do you need joints in your body?*
2. *Where are the joints that move when you do these things?*
   Run Chew Swim Write Talk Ride a bicycle
3. *How does a muscle change as it pulls on a bone?*
4. *Why are the muscles that move bones usually in pairs?*

How does your body use the food you eat?

DO YOU EVER wonder what happens to the food you eat when it gets inside your body? After you eat a meal, many things happen inside of you that you do not even know about. Your body changes your food so much that you would never guess that it once had been fruit, bread, meat, or milk.

You know, of course, that you are growing. Every part of your body is getting larger. To grow, you have to make the food into part of yourself. If you should break your arm, some of the food would help repair the broken bone. Some of your food gives you the strength to walk to school. In Unit Two you learned that some of the food you eat keeps your body warm, no matter how cold it is outdoors.



Before food can be used in any of these ways, it must be changed to a liquid. We say that food that has been changed to a liquid has been *digested*. Let us see just how your food is digested after you eat it.

First, you put your food into a kind of chopping box. Probably you have never thought of your mouth as a chopping box. But it really is. There are two rows of white choppers in this box. They are your teeth. And your teeth begin to work on your food as soon as you put it into your mouth. They break up your food and chew it into small bits.

Your front teeth are cutters. They have sharp cutting edges such as a hatchet has. They bite into a piece of toast or meat and cut it into smaller bits. Next to these cutters are some teeth that have sharp points. They help cut and tear the food into pieces. Toward the back of your mouth are some teeth with flat tops. These are the grinders. They grind the food into still smaller bits.

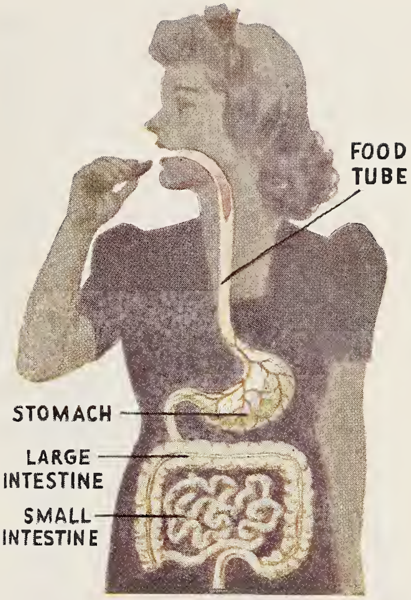
Look at the picture. Find the different kinds of teeth in the mouth shown there. Then try to find them in your own mouth. You will not find all of the large grinding teeth. Some of these will not grow in until you are older.

Did you ever notice that a liquid begins to flow in your mouth when you put food in it? Sometimes this liquid will pour into your mouth when you just see and smell something good to eat. Perhaps you have heard someone say, "That makes my mouth water." As you have learned, this liquid, or juice, is called saliva. It wets the food and makes it easy to swallow. Saliva also helps digest some of the food so that your body can use it.

The food you swallow goes down a tube into your stomach. This tube is about ten inches long and about an inch across. It goes down through your neck and joins the back of your mouth with your stomach.

Look at the picture as you are reading this page. You will see the parts of your body that digest your food, and you can follow the food through the different parts.

When food gets into your stomach, it is ready for about an hour of mixing. You can think of your stomach as a mixing bowl. The walls of this mixing bowl are full of muscles that move the walls back and forth. They squeeze the food and push it from one side to another. These walls also pour a kind of juice on the food. After a time most of the food has been changed into a liquid. Then it is ready to leave your stomach.



From your stomach the food goes down into a long tube called the *small intestine*. The small intestine is about twenty feet long and an inch across. It folds together in somewhat the way that a fire hose is folded. The walls of this long tube pour more juices on the food. All these juices help change more and more of the food into a liquid. Then the digested food is ready to pass through the walls of the small intestine into all the other parts of your body.

Not all the food you eat can be changed to a liquid that can pass through the walls of the small intestine. The part of the food that is not digested goes into another tube called the *large intestine.* From the large intestine it is passed out of the body.

It is very important to keep the parts of your body that digest your food in good working condition. Later in your science study you will learn how eating the proper foods helps you do this.

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1. *Food helps you in four ways. What are they?*
2. *How do you know that food is changed into you?*
3. *What do your teeth do to food?*
4. *Crackers are a very dry food. How can you swallow them?*
5. *How do muscles and juices help us digest the food we eat?*
6. *In Unit Two you learned that your body needs water. How has that helped you understand what you have just read?*
7. *What happens to a piece of bread after you put it into your mouth?*

How is food carried to all parts of your body?

FOOD CANNOT HELP you grow or do you one bit of good if it stays in your small intestine. It is like the food in the grocery store near your home. As long as the food stays in the store, you cannot use it. It must be brought to your home first.

Every part of your body needs food. Your head needs some of it, and so do your feet. Some of the food must be taken to your arms, to your fingers, to all of your muscles, and to your brain. How do you think this food gets from the small intestine to the other parts of your body?

Something must carry the food around in your body. This carrier is your blood. Look at the picture on page 79. This picture shows the wonderful network of tubes, or *blood vessels*, that reaches every part of the body. Look at the picture again and find the heart. This is the pump that keeps the blood moving around through the tubes. Put your hand over your heart. Can you feel your heart beat? It is pumping blood.

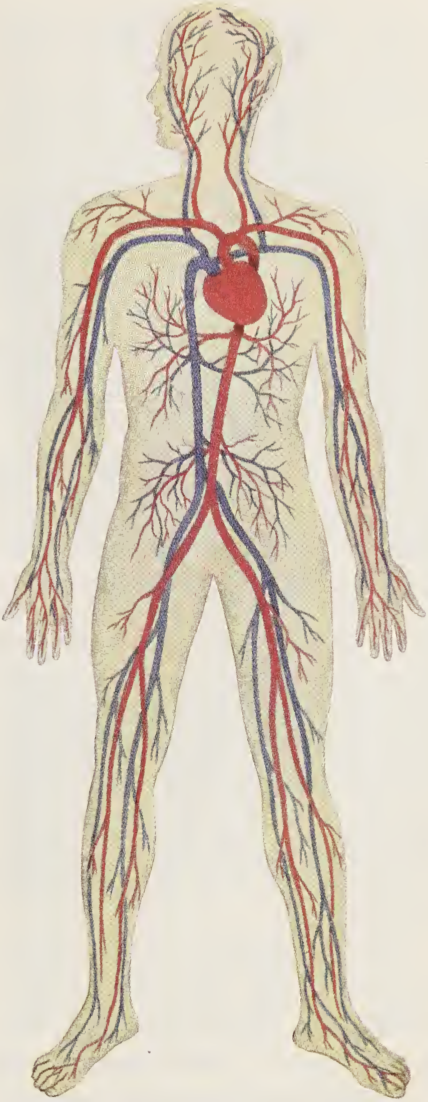
Your heart is really a big muscle that is hollow. Blood flows into this hollow muscle from some of the blood vessels. When your heart is full of blood, the muscle squeezes the blood out through other blood vessels. In a moment it fills with blood again. Another squeeze, and out goes the blood. This pumping keeps the blood flowing through the blood vessels day and night.

Look at the picture again. Do you see that the blood vessel which carries the blood away from the heart is very large? Small branches come out from this large vessel somewhat like the branches on a tree. These branches divide into still smaller branches. At last, they get so small that they carry blood into even the smallest part of you. The picture does not show all the small vessels.

As this stream of blood flows through your body, it leaves some of the food it is carrying. It leaves food in all parts of your body, just as a grocery truck might leave food at your door and at the doors of all your neighbors.

Of course, the blood would soon deliver all the food it holds unless it could get a new supply. Some of the blood that flows out of your heart is carried to the small intestine. There are thousands of tiny blood vessels in the walls of the small intestine. The food in the intestine is a liquid that can pass through the walls of the intestine into these tiny blood vessels. When the food gets into the blood, away it goes to all parts of your body. Now you see how the blood gets a new supply of food.

Before the new supply of food can be sent out to the rest of your body, the blood must go to your heart. The tiny blood vessels in the walls of the



The vessels that are colored red take the blood away from the heart. The ones that are colored blue take the blood back to the heart again.

small intestine join to make larger vessels. These larger vessels join with others that are carrying blood back to your heart. Then your heart pumps the blood to all parts of your body.

1. *Why must food be carried to all parts of your body?*
2. *Why must food be digested before it can get into the blood?*
3. *How do the big blood vessels that leave the heart carry blood to all parts of your body?*
4. *How is blood kept moving through your body?*
5. *How are the blood vessels like the branches on a tree?*

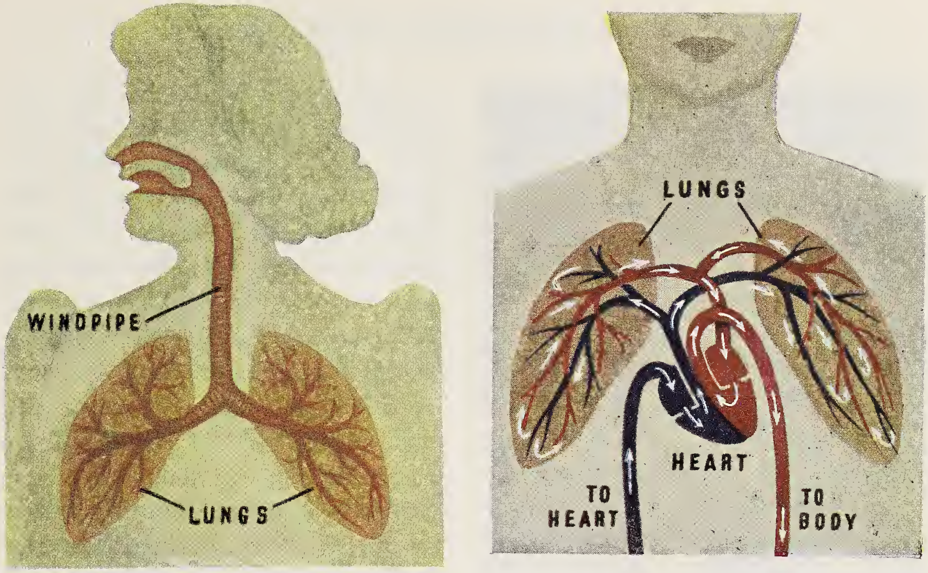
How do all parts of your body get oxygen?

YOU KNOW THAT you could not live for more than seven minutes if you stopped breathing. And you have learned that your body must have oxygen to use the food that you eat. You know that the oxygen you need comes from the air. You cannot move without oxygen, and you cannot grow without it. Oxygen, like food, is needed by every part of your body. It must be carried by the blood, too.

You already know how you get air into your body. Air comes in when you breathe. Suppose you take a deep breath and see what happens. Do you feel your ribs move out? As they do, air from the outside rushes in through your nose or mouth and fills your lungs. Now breathe out. You can feel your ribs move back in again. As they do, air is pushed out of your lungs through your nose or mouth.

Now look at the picture on page 81. Air gets into your body through your nose or mouth. Then the air goes into your *windpipe*. The windpipe goes down through your neck. Then it branches into two large tubes. You have two lungs, and one branch of the windpipe goes to each lung.

Your lungs are somewhat like two big sponges with hundreds of tiny pockets in them. After the windpipe branches into two large tubes, each of these parts keeps branching into smaller and smaller tubes. Every one of the tiny branches ends in one of the small pockets in your lungs. These little pockets are filled with air when you breathe in. From there the oxygen gets into your blood.



The picture at the left shows you how the air you breathe in gets to your lungs. Look at the picture on the right and follow the white arrows. You will see how your blood gets from your heart to your lungs and back again with a new supply of oxygen.

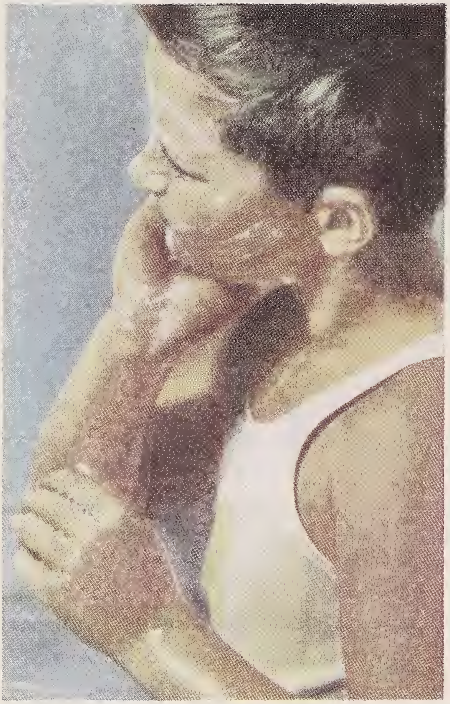
Now let us see how the oxygen gets from the air in these pockets into your blood. During its journey around your body, all of your blood goes through your lungs. The blood vessels separate into tiny tubes in the lungs. The walls of every air pocket are full of these tiny blood tubes.

The walls of the air pockets and the walls of the blood tubes are very thin. So the oxygen passes easily from the air pockets into the blood in the tiny blood tubes. When the oxygen gets into your blood, it is carried everywhere your blood goes. It is unloaded all through your body while the food is being unloaded. The blood that has unloaded its oxygen goes back to your heart. Then it goes to your lungs for a new supply of oxygen.

---

1. *Where does the air go when you breathe it in through your nose or mouth?*
2. *Where does the blood get the oxygen to carry through your body?*
3. *How is the way that the blood gets oxygen like the way that the blood gets food?*

What does your skin do for your body?



Your clothes may get soaked in a heavy rain, but none of the water gets inside your body. Your body has a covering that keeps the water out. This covering is the skin. It covers all the parts of your body, from head to toe.

But keeping water out of your body is not the only thing your skin does. Your skin also keeps out dirt. Even more important, your skin keeps out *germs.* Germs are very tiny plants or animals that can make you sick when they get inside your body. Most germs cannot go through your skin unless the skin is cut or burned. A cut or a burn in the skin is an open door for germs that can make you sick. That is why you must always take care of a cut or a burn and keep your skin clean. Washing your face with soap and warm water helps keep the germs off.

If you could look at your skin through a magnifying glass, you would find hundreds of tiny openings. These small openings, or *pores,* let the *perspiration* come out of your body. Perspiration is a liquid. It is mostly water. But it also has in it materials that your body needs to get rid of. These waste materials are formed when food is used by your body. Some of these waste materials come out of the body in perspiration.

---

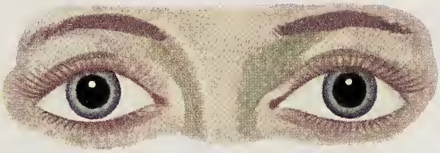
1. *In what three ways does your skin help you?*
2. *Tell what you have learned about germs.*
3. *Why should you wash yourself with soap and warm water?*

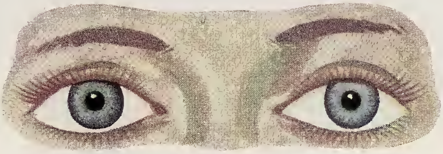
How do you know what goes on around you?

Do you ever play "blindman's buff"? If you are the "blindman," you have something tied over your eyes so that you cannot see. Your friends are in a circle around you. One of them comes inside the circle. And you try to catch him and guess who he is. You listen carefully, and you hear him behind you. You turn around, but he has moved. Then you hear him on the other side. You run after him.

In a few minutes you catch him. You feel his jacket, and you can tell by feeling it that it is made of leather. John is the only one who has a leather jacket on. So you know it must be John. Your *sense of hearing* and your *sense of touch* have helped you catch John and tell who he is.

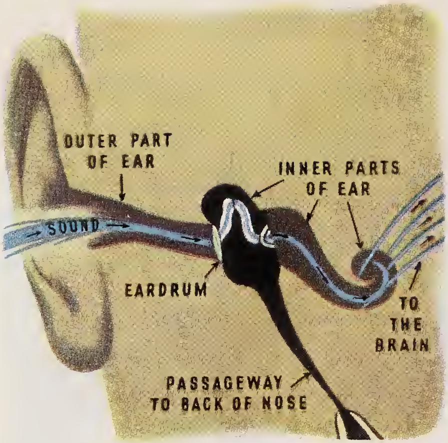
There are five senses that help you. They are very important to you because they tell you what is going on around you. Let us see what these five senses are. Suppose you look at your eyes in a mirror. Do you see the very dark place in the center of each eye? This dark spot is the *pupil* of the eye. The pupils are like windows in your eyes. They let in the light. If these pupils did not let in the light, you could not see what is going on around you. You would not have any *sense of sight*.





If there is too much light coming into your eyes, the pupils have a way of shutting out some of the light. Very tiny muscles in your eyes make the pupils larger or smaller. On very bright days, or if you are reading in bright light, the muscles close the pupils part way so that less light comes in. At night, or when you are in a dark place, the muscles open the pupils of your eyes wider to let in more light. In the picture, which eyes are in a bright light?

Have you ever gone from the bright outdoors into a dark room? Do you remember how dark it seemed at first? Then you began to see things. In a few minutes you could see fairly well. The muscles in your eyes needed time to open the pupils wider to let in more light. Inside the dark room there was not much light. So the pupils needed to be open wide.



Your eyes tell you what is going on around you. You can see things that are very close to you, and you can see things that are very far away. Your eyes tell you how large or small a thing is. They tell you its color. If you had no eyes, it would be like living in a dark closet all the time.

Your ears give you the *sense of hearing*. They are your sound catchers. They can catch the sound of the wind whispering through the trees, and they can catch the sound of a great explosion. They catch hundreds of different sounds every hour. Without these very important sound catchers, you could never hear what people tell you. They would talk to you, and you would only see their lips move. Think of the interesting and important things you would miss if you could not hear.

The outside of your ear catches these sounds. Then they travel to the inside of your ear. You can hear sounds coming from all directions. When a sound comes from one side of you, you hear it louder in one ear than in the other. This is how you can tell the direction of a sound. The picture shows you what your ear looks like and the path that sounds follow through it.

Sometimes you can tell what is cooking on the stove without going into the kitchen. You do not see or hear what is cooking, but you know what it is. Of course, you know how you can tell. You smell it. You are using your *sense of smell*. Some of the smell of the cooking food comes out into the air in the room. You breathe the air through your nose, and then you know what you are going to have for dinner.

Let us suppose that you are blindfolded. You also are holding your nose so that no air can get in. Now someone puts a piece of candy in your mouth. You cannot see it, and you cannot smell it. How can you tell what it is? You use your *sense of taste*. In your mouth are tiny parts, or *tasters*, that tell you things about anything you put in your mouth. If you did not have these, a piece of candy and a pickle would be the same to you because you could not taste either one.

These men are learning to be teachers of blind people. They are blindfolded and cannot see what they are eating. Which senses tell them what they are having for dinner?

Sometimes your mother tastes milk to see if it is sweet. When you are cracking and eating nuts, you may find spoiled ones. You cannot always tell that a nut is spoiled by looking at it. But your tasters tell you in time so that you do not swallow it. In this way your tasters sometimes keep you from harm. When you taste food and find that it has spoiled, you do not swallow it. If food that has spoiled gets into your stomach, it may make you sick.

Your senses tell you in many ways what is going on around you. You can see and hear. You can smell and taste your food. And you can feel things that you touch.

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1. *Tell how your senses have helped you during the last hour.*
2. *Which senses tell you what is going on at a distance from your body?*
3. *What do your eyes tell you about a thing?*
4. *What happens in your eyes when you go from the bright sunlight into a dark room?*
5. *Smell and taste often work together to tell you what you are eating. How could you experiment with an onion to see if this is true?*
6. *Which senses help you tell if food is spoiled?*

What keeps the parts of your body working together?

EVERY PART of your body must keep working. Your heart must keep pumping your blood. Your muscles must keep moving your body. Your lungs must do their work. Suppose your lungs took an hour's rest, or your heart stopped work at five o'clock in the afternoon! All the other parts would stop working, too, and you could not live.

The director of your body is your brain, inside your skull. The other parts of your body do what the brain tells them to do.

Your senses are somewhat like telephones. They get messages from the world around you. But you do not really understand the messages until they are carried to your brain. Your *nerves* are the message carriers. They are like the wires in a telephone system. They run to and from every part of your body. Thousands of them go to your skin and other parts of your body. They carry messages to your brain. Then they carry messages back from the brain to your arms and legs and other parts of your body.

The nerves that connect your brain and the other parts of your body make up a large bundle called the spinal cord. The spinal cord, you remember, is in the hollow tube running through your backbone.

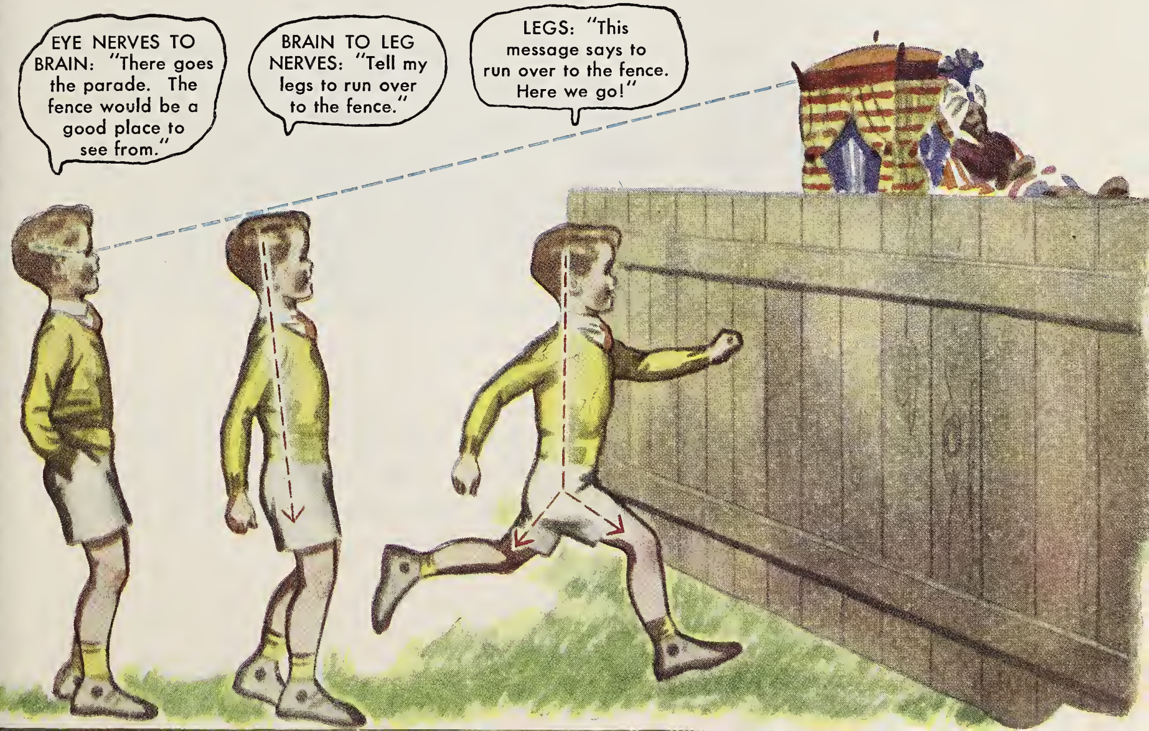
Suppose you are watching a circus parade. How do you think your nerves work? Let us see how your nerves act when you are watching the parade.

Listen! Do you hear the drums in the band? The parade is coming. The sound from the beating drums travels to your ears. Away goes the message along the nerves from your ears to your brain. You hear the people talking and the sound of the peanut wagon's whistle.

And that is not all. Your eyes are seeing things, too. Look at the red and white flags. Now the band is coming, and the horns are shining in the sun. Are those elephants that are following the band? Are those clowns in the yellow coats? Hundreds of messages have been carried from your eyes to your brain in these few minutes.

Everything that you see and hear makes you want to be nearer the parade so that you can see better. Your eyes see a fence. Your brain tells you that you could see better from the top of the fence. Your brain sends a message to your legs, and you run toward the fence. While you are running, you fall and bump your head. Nerves carry a message of pain to your brain. Your brain sends a message to your hand, and you rub the hurt spot.

There are still other nerves at work. You smell popcorn, see the popcorn


EYE NERVES TO BRAIN: "There goes the parade. The fence would be a good place to see from."
BRAIN TO LEG NERVES: "Tell my legs to run over to the fence."
LEGS: "This message says to run over to the fence. Here we go!"

wagon, and buy a bag. As you eat the popcorn, nerves carry a message. And you can taste the popcorn. You say this must have been a very busy day for your brain and nerves. Every day is a busy day for them.

Perhaps you are wondering why the messages do not get mixed up when there are so many of them every minute. That is because messages can travel along nerves in only one direction. Some nerves carry messages from different parts of your body to your brain. Other nerves carry messages from your brain to different parts of your body. When your brain receives a message, it decides what to do. Then it sends a message along the nerves that carry messages from your brain to the different parts of your body telling them what to do. Your brain is the part of your body that does your thinking for you. It keeps the parts of your body working together. A brain is the best director that ever told anyone what to do. It can do many things at once and not get mixed up.

1. *What part of your body is the director?*
2. *Where is the director in your body?*
3. *Why does your body need a director?*
4. *How are messages carried to and from the brain?*

QUESTIONS TO ANSWER

1. How are each of these parts important to your body?

Joints
Heart
Muscles
Lungs
Brain
Teeth
Skin
Nerves

2. What must happen to food before your body can use it?

3. Describe how the blood carries two very important things around your body.

4. Which of the ways to discover things did you use in this unit?

5. What parts of your body have joints like the hinges on a door?

6. Why do you think that you are more intelligent than a dog?

7. What part of your body is like the central station of a telephone system? Tell why you think so.

8. What do we mean when we say that a food is hard to digest?

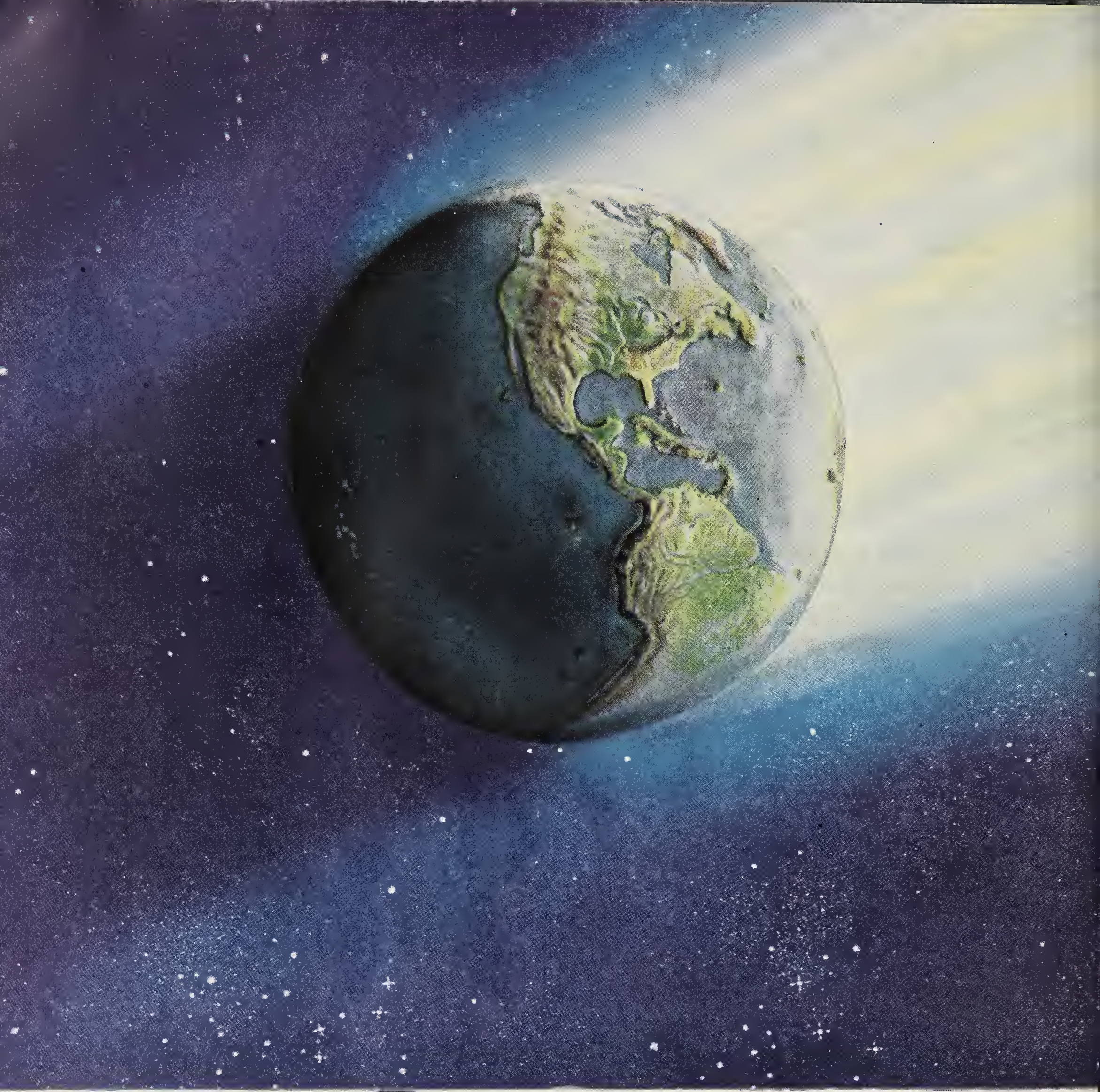
9. Why does your mother often tell you to eat your food slowly?

10. How is the food you eat like the gasoline that is used by an automobile engine?

11. Try to remember what happened this morning as you walked to school. Tell how the message carriers of your body worked so that you knew what was happening as you walked along.

THINGS TO DO

1. Get a large joint from a meat market. Study the bone to find out
   - *a*) What the inside looks like.
   - *b*) How muscles are fastened to it.
   - *c*) How it is fastened to another bone.
   - *d*) How the blood gets inside the bone.
2. Make a list of five things you have done today. What parts of your body did you use in doing them?
3. Write a story telling how some of the bread you eat is changed and how it travels through your body until it gets into your big toe.
4. Make a list of the new science words you have learned in this unit and tell what each word means.
5. Look closely at the back of your hand to see how the blood vessels branch out.
6. Have your teacher show you where your pulse is and how to use the pulse to count how fast your heart is beating. Take your pulse when you are sitting down. Then jump up and down a few times and count your heartbeats again. What happens? Can you see how this helps your body?
7. Count how many breaths you take in a minute when you are sitting down. Now jump up and down a few times and count the number of breaths. What happens? How do you think this helps your body?



★ In Unit Four You Will Learn ★

★ How the earth gets its light ★ What the shape of the earth is ★ ★ How the earth moves ★ Why we have daylight and darkness ★ ★ Why the earth is like a clock ★ What makes a year ★ How the hours of daylight and darkness change during the year ★ ★ Why summer days are warmer than winter days ★

★ UNIT 4 ★

Why Do We Have Days and Nights?

WOULD YOU BELIEVE that day comes because a sun god rolls the sun into the sky? Would you believe that night comes because the god carries the sun away? Would you believe what a small boy once said about what makes night? "I know what makes night," he said. "The sun goes into my neighbor's woods. That makes night."

Of course, you know that night and day are not caused by a sun god. And you know that the sun does not go into a woods at night. But do you know what really does cause day and night?

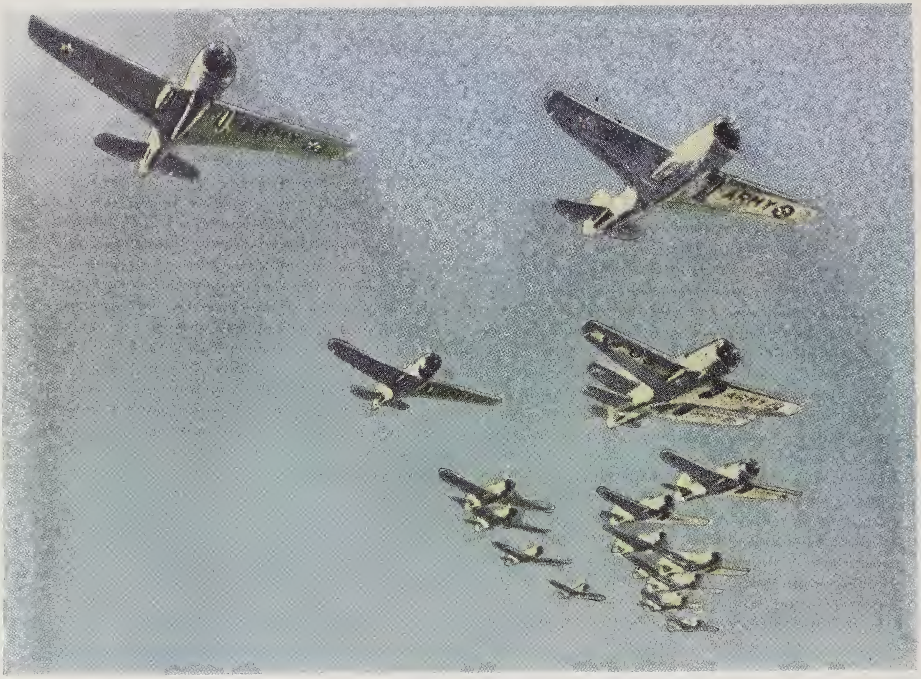
Thousands of years ago people began to wonder why darkness came at night and why light came again every morning. They watched the sun as it seemed to move across the sky. They studied the earth, too. But it took them hundreds of years of study and careful watching to find out what causes day and night.

In this unit you will read about some of the very important things that people have learned about the earth and the sun. These things will help you understand why some of the time we have daylight and some of the time darkness on the earth.

How does the earth get its light?

HOW MANY WAYS can you think of to light a room? You can use electric lights. You can use lamps that burn gas or lamps that burn oil. You may even light the room with candles.

All of these lights are alike in one way. They are all very hot. The electric-light bulb is hot. So you can be sure that the thin, glowing wires inside must be hot, too. The wires in the electric-light bulb get so hot that



These airplanes are all the same size, but the ones that are far off look much smaller than the ones that are near.

they glow and light the room. The burning oil in the wick of the lamp gets so hot that it gives off light. Many kinds of materials give off light if they get hot enough. Have you ever seen a piece of iron that had become so hot that it glowed with a red or white light?

Now if someone asked you this question, what would you answer? "Why does the sun give light?" A good answer would be, "The sun gives light because it is very, very hot."

The sun that warms us and gives us light looks like a big yellow ball. It is made of very hot gases. Nothing on earth is so hot as the sun. The temperature of the outside of this glowing ball is about 100 times as hot as the temperature is on the hottest day on earth. The inside of the ball is thousands of times as hot as any fire you could ever make!

This ball of glowing, hot gases may not seem very large to you. You would probably guess that it is

Scientists can take pictures of the sun that show some of the hot gases shooting far out from the edge.

much smaller than the earth we live on. But the sun is really not small. It is more than a million times as large as the earth! It looks small because it is so far away. Looking at the sun is like watching an airplane in the sky. When the airplane is far up in the sky, it looks very small. As it comes closer, it looks larger. A house or a ship or a tree or an automobile looks small when it is far away. The sun looks small because it is millions of miles away from us. It is 93 million miles from the earth to the sun.

You can understand how large the sun is if you make two drawings on the blackboard. Draw a circle a quarter of an inch across on the board. Next to it make another circle twenty-seven inches across. Write "The Earth" over the small circle and "The Sun" over the large circle. This will help you see how big the sun is.

It is a good thing that our earth does not move any nearer the sun. If it did, we would all be baked by the heat. But do not worry. The sun and the earth will not get any closer together than they are. The sun will go on lighting and warming the earth for a long, long time.

But you know that the sun lights the part of the earth where we live only part of the time. Part of the time the place where we live is in darkness. Before you can understand why this is true, you need to know some things about the earth. You need to know the shape of the earth and how the earth moves.

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1. *How do we know that the sun is very hot?*
2. *The sun is much larger than the earth. Why does it look so small?*
3. *Why is the sun important to us?*

What is the shape of the earth?

You have probably heard that the earth is shaped like a big ball. You may have a hard time believing that we are walking around on a ball. But that is just what we are doing, for the earth really is shaped like a big ball.

Perhaps you are wondering why the earth does not seem round as you look out across the fields or the ocean. The earth does not look round because it is so very large. You can look miles away, and you cannot tell that the earth curves at all. You cannot see enough of the earth to be able to tell that it curves.

It is not surprising that hundreds of years ago most people thought the earth was flat like a table. They did not know as much about the earth as you will know when you have studied this book. They were sure that if they went far enough, they would come to the end of the earth. They were afraid to travel very far out on the ocean. They thought that the ship would come to the edge of the earth and fall off!

As people learned more and more about the earth, they began to wonder if it really were flat. Then a few thoughtful men began to believe that the earth was a big ball. Most people just laughed. They would not believe anything unless they could see it. And, of course, the earth looked flat to them just as it does to us.

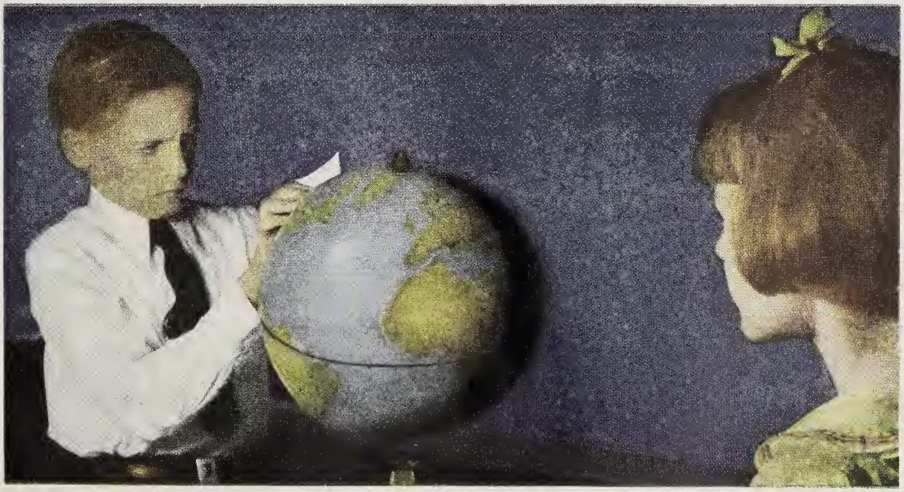
But the men who thought the earth was a ball found a way to prove that they were right. They could not get far enough above the earth to see its shape. What do you think helped them find out the real shape of the earth?

In the days of long ago people did not do much traveling. Whenever a ship came back from sea, great crowds gathered at the shore to watch it. Some of the men who often went to watch the ships come in noticed something that seemed strange to them. They noticed that when the ship was far out, they could see only the top sails. As the ship came nearer, they could see the lower sails. As the ship came still closer, they could see the body of the ship.

This made them feel sure that the earth must be shaped like a ball. For if the earth were flat, all of the ship could be seen in the distance at the same time. It would just look bigger as it came nearer. Study the picture on page 94. Do you think these men were right?

If you do this experiment, you can understand how watching ships come in helped men learn that the earth is a big ball. Have someone hold a tiny boat on a globe, as you see in the picture. The boat should be on the opposite side of the globe from you so that you cannot see it. Then have the boat moved slowly around the globe toward you. Which part of the boat do you see first? Do the experiment again and watch closely. Name the different parts of the boat as you see them.

Now take the boat from the globe and put it at one end of a long table. Think of this table as a flat earth. Go to the other end of the table and stoop down until your eyes are on a level



with the table top. Watch the boat as someone moves it toward you. Do you see first just the top of it? Or do you see all parts of it at the same time? This experiment shows you that if the earth were flat, you would see all parts of a ship at the same time. Because the earth is a ball, you can see at first only the top parts of a ship as it comes toward you. Later you see the rest of it.

Christopher Columbus was one of the first sailors who believed that the earth was a ball. He believed that he could sail around it, and he tried to do so. But he landed on one of the islands off the southeastern coast of America.

Since the time of Columbus thousands of people have traveled around the earth. Aviators have flown around it in a few days. People have also gone very high above the earth in airplanes and balloons. They have been able to take pictures which show that the earth curves.

1. *Why do you think it took people so many years to find out that the earth is shaped like a ball?*
2. *How does the experiment show you that the earth is shaped like a ball?*
3. *What are two other reasons for believing that the earth is shaped like a ball?*

How does the earth move?

YOU HAVE LEARNED now that the earth is shaped like a ball. You also know that the sun gives it light. The sun shines all the time. But you know that the earth is dark part of the time at the place where you live. You must learn some other things about the earth before you can understand what causes day and night.

For a long time people wondered why we have days and nights. They knew that either the sun or the earth moved. Because they could see the sun in different places in the sky, they believed that the sun moved. They believed this for thousands of years. But some people began to wonder. They not only looked carefully at things, but they thought about the things they saw. They wondered if it was not the earth that moved instead of the sun.

At last, one of the people who had watched carefully proved that the earth spins around like a top. You can understand how the earth turns if you watch a top that is spinning. Turn a globe around fast and watch it spin, too. The top, the globe, and the earth all turn around on an *axis*.

You can understand what turning on an axis means if you try this experiment with an orange. Roll the orange on the table. Do you see that it turns this way and that way? Now push a short, stiff piece of wire through the orange and whirl the orange around on the wire. This time the orange does not turn in different directions. It keeps spinning around in the same place. It spins around on the piece of wire. That is what we mean when we say that something is turning on an axis.

Now take a quarter or some other coin and hold it on edge. Snap it with your finger so that it will spin on the table. Do you see that it turns just as the orange did except that there is no wire through the coin? The coin is spinning on its axis, too. Can you imagine that there is a line running through the coin like the wire that runs through the orange? The axis of the coin is an imaginary line on which the coin spins.

We say that the earth turns, or *rotates,* on an axis, too. It rotates from the west toward the east. It keeps rotating in the same direction just as the coin did. There is no rod running through the earth. The earth's axis is an imaginary line through the earth.

The ends of this imaginary line are called *poles.* One end is called the North Pole of the earth, and the other end is called the South Pole. Of course, there are no poles sticking out of the earth. Wherever you are on the earth, the direction north is always toward the North Pole. The direction south is always toward the South Pole.

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1. *What does rotating on an axis mean?*
2. *How can an orange be made to spin on an axis?*
3. *Why is the spinning of the earth more like the spinning of a coin than the spinning of an orange?*
4. *What are the poles of the earth?*

Why do we have daylight and darkness?

NOW YOU HAVE learned three very important things to help you understand why we have darkness and daylight.

1. The sun lights the earth.
2. The earth is shaped like a ball.
3. The earth rotates on its axis.

A top spins around in a flash. The earth spins very fast, too. But the earth is so big that it takes twenty-four hours to spin around on its axis just once.

Now if you do this experiment, you can see why we have day and night once every twenty-four hours. You need a globe to use for the earth and a flashlight or some other light to use for the sun. Darken the room and hold the flashlight near the globe. Look at the globe. You see that only part of it is lighted. How much of it is lighted?

Remember that the flashlight is the sun and that the globe is the earth. Make a large chalk mark on the globe to show where you live on the earth. Turn the globe from west to east all the way around once on its axis. Do this slowly. What happens to the place where you live? Is it light part of the time and then dark part of the time? When the chalk mark is lighted, you are having daytime. When it is dark, you are having night-time.

This experiment shows that during one turn of the earth, the place where you live is light part of the time and then it is dark part of the time. When the place on the earth where you live faces the sun, you have daytime. When it faces away from the sun, you have night-time. You remember that the earth rotates once in twenty-four

hours. So during every twenty-four hours we have daytime once and night-time once.

Turn the globe so that the place where you live is having night. Now turn the globe slowly from west to east to show where your home will be when you are getting up in the morning. Turn it farther until it shows noon at your home. Keep turning the globe to show where your home is when school is out in the afternoon. Now turn the globe to show that it is almost night.

In the experiment which did you move, the globe or the light? You turned the globe, but the light did not move. It is this way with the earth and sun. The sun does not travel across the sky. The earth is turning on its axis from west to east. That is what makes the sun seem to move across the sky. We first see the sun in the east in the morning. By noon the earth has turned more, and we see the sun overhead. By evening the earth has turned still more, and we see the sun low in the west. At last, we cannot see the sun at all. And it soon becomes dark. It is night.

It took people many years of study to find out that the earth is spinning around like a top. For a long time it seemed to them that the sun must surely be moving across the sky. You can see why they thought this.

Sometimes it is even hard for you to tell whether you are moving past some object or whether the object is moving past you. Have you ever been on a train and said this to yourself? "Is my train moving? Or is the train on the next track moving?" If your train starts smoothly so that you cannot feel it move, the train on the next track seems to be moving.

---

1. *Which of these things do you need to know to explain why we have day and night?*
   - *a) Sometimes clouds hide the sun.*
   - *b) The earth rotates on its axis.*
   - *c) The earth gets its light from the sun.*
   - *d) The earth is round like a ball.*
   - *e) Some nights are very dark.*
   - *f) Only half the earth can be lighted at one time.*
2. *How many times does the earth turn all the way around on its axis in one week?*
3. *In your own words tell why we have day and night.*

How is the earth like a clock?

THE EARTH IS the largest clock you have ever seen, and it is always on time. Does this idea puzzle you? Probably you have thought that a clock is a piece of machinery that tells us what time it is. You are right. A clock is a machine that tells us the time of day or night. All day and all night the hands of the clock turn slowly around, pointing first to one number and then to the next. You say that it is one o'clock, or two o'clock, and so on.

But what do you mean when you say that it is one o'clock or two o'clock? Suppose your clocks at home are wrong. Then how do you find out what the right time is? Perhaps you listen to the radio to find the right time. Or maybe your father says, "My watch is right. I set it by the clock in the jewelry store this morning." But how do the radio station and the jeweler get the right time?

If you are playing outdoors and do not have a watch with you, is there any way you can tell about what time it is? Probably you would look at the sun. If the sun is almost overhead, you say, "It is just about noon. It must be time for lunch." If the sun is low in the west, you say, "It must be late in the afternoon. The sun is almost down."

That is the way people used to tell time long ago, before clocks were

made. They used the sun as a clock. You really tell time that way even when you look at a clock. When you look at the clock, the clock is really telling you where the sun is. Now let us see why that is true.

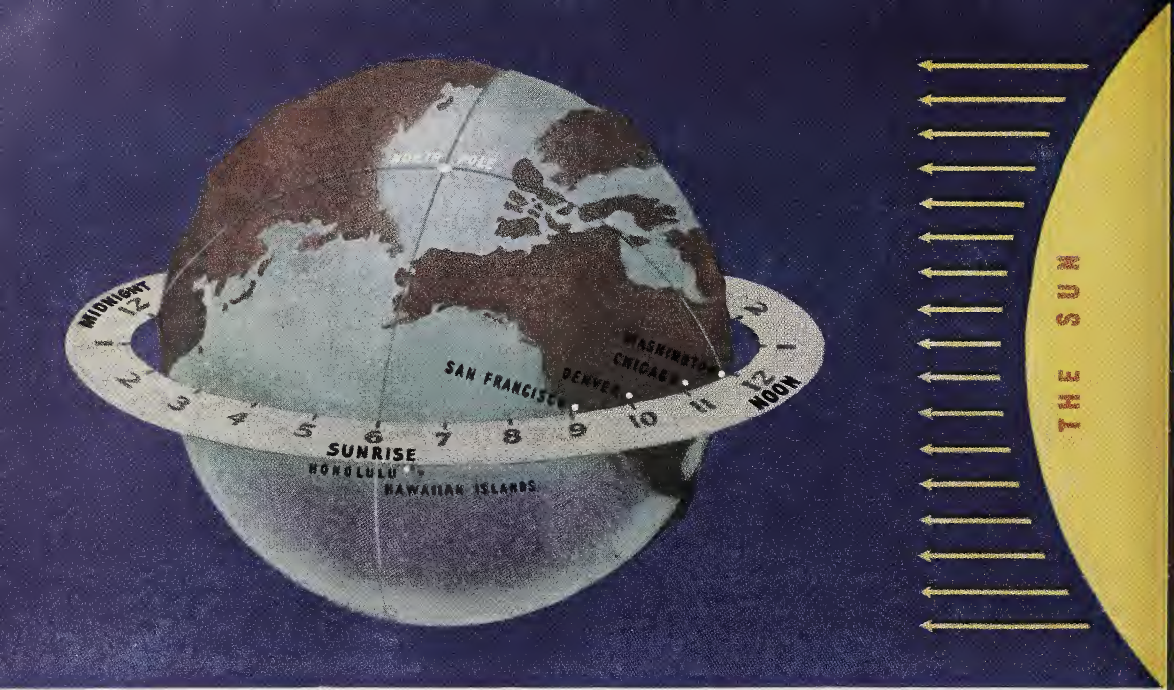
You know that it takes the earth twenty-four hours to turn all the way around on its axis. When the earth has gone halfway around, we say that twelve hours have passed. When it turns the rest of the way around, another twelve hours have passed.

When the earth has made one complete turn around on its axis, we say that a day has passed. We divide the day into twenty-four equal parts, called hours. A day is made up of the hours of daylight and darkness. But how can we tell when the earth has made one complete turn? We cannot see it turn.

If you shut your eyes on a merry-go-round, you cannot tell how far you have turned or how many times you have turned around. But if a friend of yours is standing beside the merry-go-round, you can look at him and count the times you pass him. Then you know how many times you have gone around. You can also tell when you have gone halfway around.

We watch the sun to tell when the earth has turned once. We can also tell how far the earth has turned at any time. We can also watch the stars to find out how far the earth has turned.

In the city of Washington there are several very important clocks. They



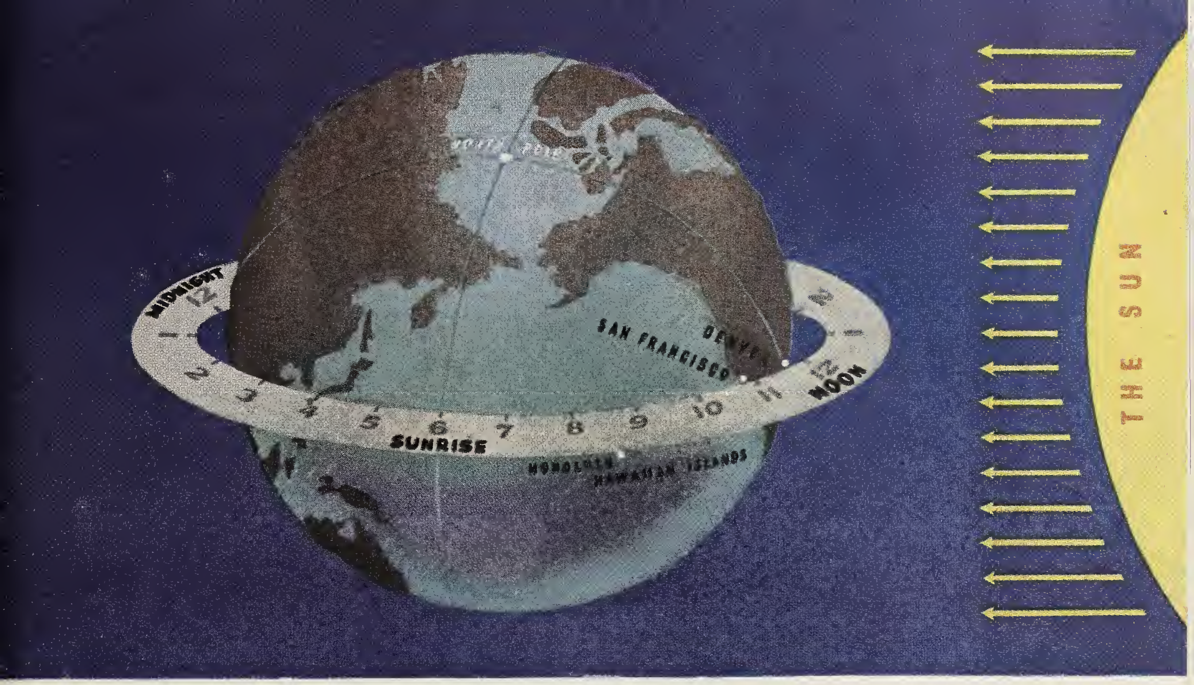
When the earth has turned so that it is noon in Washington, what time is it in Chicago? What time is it where you live?

are always being checked to see if they show the correct time. Every clear night a scientist looks at the stars through a *telescope* and finds out what time it is. Then he looks to see if these clocks show the correct time.

Several times a day he sends signals by radio and telegraph to all parts of the country to let people know what the correct time is. Radio stations and jewelers can get the right time, and people can set their clocks. Twelve o'clock noon is one of the times when the signals are sent out.

When it is twelve o'clock in the city of Washington, is it twelve o'clock everywhere in the United States? You can answer this question by doing an experiment. Use a flashlight and globe as you did in the experiment on page 98. Turn the globe so that it is noon in Washington. That is the time the sun is highest in the sky.

Now if you look at Chicago, Denver, and San Francisco on the globe, you can see that it will not be noon in these cities. Before it will be noon in Chicago, you must turn the globe some more. When it is twelve o'clock in Washington, it is eleven o'clock in Chicago, ten o'clock in Denver, and nine o'clock in San Francisco. This means that you must turn your watch



Now the earth has turned so that it is noon in Denver. What time is it in San Francisco? What time is it in Honolulu?

back when you cross the country from east to west. When you travel from west to east, you must turn your watch ahead.

When you look at your clock and see that it is twelve o'clock noon, you are really finding the time when the sun is highest in the sky. At three o'clock in the afternoon you know that it is three hours past the time when the sun was highest in the sky. You know that it will take twenty-four hours for the earth to turn before the sun is at the same point again.

Do you see how the earth is used as our clock? Your clock at home may run too fast or too slow. But the earth keeps on rotating at the same speed year after year. It rotates once every twenty-four hours.

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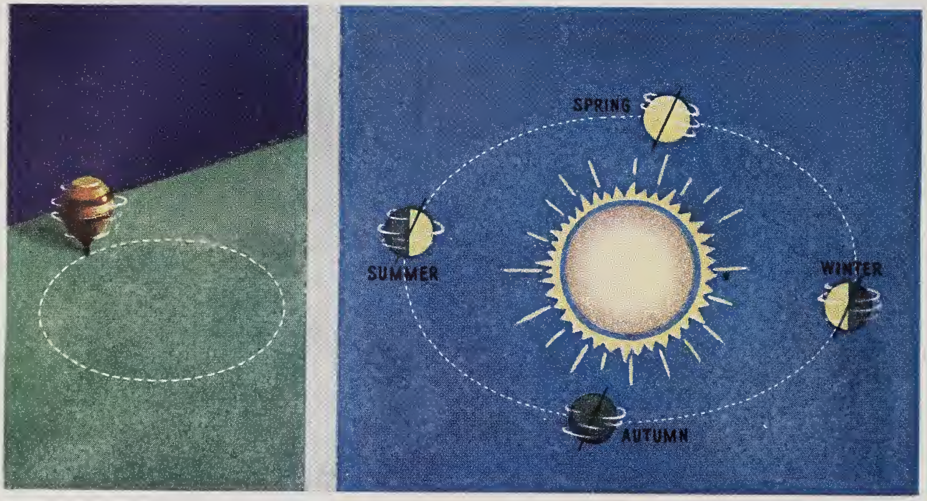
1. *Explain how the earth is like a clock. If you have a globe, use it to show what you mean.*
2. *Why is the time different in different parts of the country?*
3. *How many times has the earth turned around on its axis since yesterday at this time? How many hours have passed?*



What makes a year?

You have learned what makes a day. It is the time the earth takes to turn all the way around once on its axis. But you do not measure your age in days. You measure it in years. And years are measured by another way in which the earth moves.

Look at the picture on this page. It shows you that the earth is doing something else besides spinning like a top. It is traveling around the sun all the time, just as you move around the center of a merry-go-round. Sometimes when you spin a top, it moves slowly around almost in a circle. Can you see that the top and the earth are both making two kinds of movements? Each one is spinning on its axis and traveling in a circle, too.

You know that it takes twenty-four hours for the earth to turn around once on its axis. But it takes 365¼ days for the earth to travel all the way around the sun. A year is the time it takes the earth to travel, or *revolve*, once around the sun. This means that if you are ten years old, the earth has revolved around the sun ten times since you were born. If anyone asked you how you measure your age, your answer could be "I get a year older every time the earth revolves all the way around the sun."

Look again at the picture on this page. Do you see the names of the four seasons of the year? Suppose that the earth begins its trip around the sun in January. When summer comes, has the earth traveled halfway around the sun, three quarters of the way, or one quarter of the way? How far has it traveled when spring comes?

Do you see that in summer the earth is on the opposite side of the sun from where it was in winter? When is it on the opposite side from where it was in autumn? The seasons tell us how far the earth has traveled around the sun since the year began. Each year is divided into four seasons. When four seasons have passed, the earth has revolved once around the sun.

---

1. *What two movements does the earth make?*
2. *Which movement gives us days? Which gives us years?*
3. *How many times has the earth traveled around the sun since you were born? Since you started going to school?*
4. *How many times does the earth rotate on its axis while it revolves once around the sun?*

How do the hours of daylight and darkness change during the year?

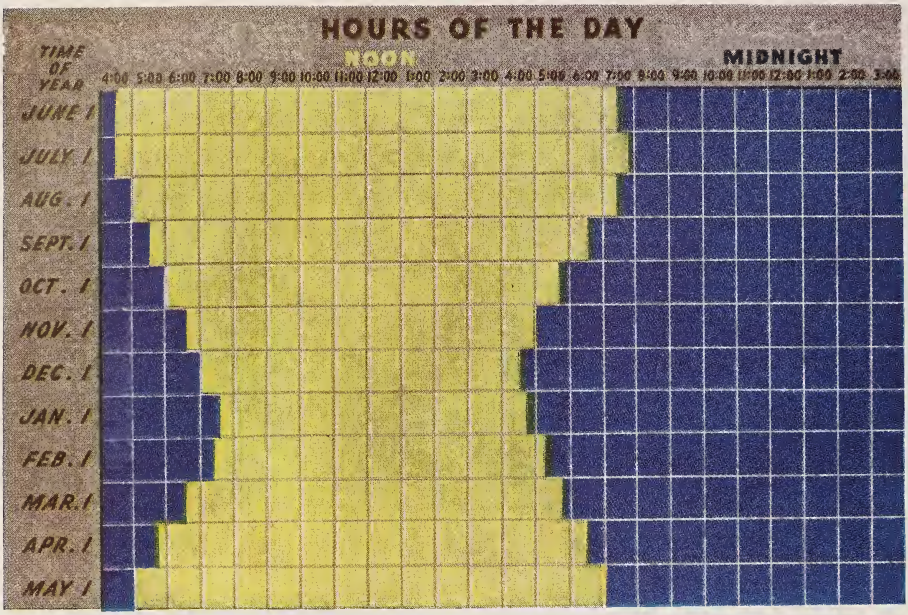
Have you ever read this little poem?

In winter, I get up at night
And dress by yellow candlelight.
In summer, quite the other way,
I have to go to bed by day.

What does the poem tell you about daylight and darkness during the year? Of course, you have noticed that as the year passes by, some days have many more daylight hours than others. Summer days have more hours of daylight than winter days. In summer, the sun is up long before you get out of bed. And after supper the sun still gives light enough for you to play outdoors. At seven o'clock on summer evenings you can see well enough to play a game of ball.

Winter days have fewer hours of daylight than summer days. In winter, the sun does not come up until you are having breakfast. And the sun goes down before you eat your supper. You do not play outdoors after supper. You stay indoors and read or play games. If you go outdoors, it is dark.

You can find out just how much the amount of daylight changes by keeping a record of the hours of daylight and darkness. Daylight begins when



we first see the sun in the east. And it ends when we no longer see the sun in the west. It may be hard for you to tell the exact time of the sunrise every morning. You probably do not get up early enough. And clouds or buildings often hide the sun. But the time of sunrise and sunset for each day is printed in the newspapers.

Here is a record that some children once made of the number of daylight hours. You can see that there are twenty-four squares in each row across the chart. Each square is an hour of time. The yellow squares show the number of daylight hours. The blue squares show the number of hours of darkness. The date beside each row of squares shows the time of the year. Look carefully at the chart and then answer these questions.

---

1. *Which four months have the most daylight?*
2. *Which four months have the least daylight?*
3. *Is there much daylight or little daylight on your birthday?*
4. *In which months are the hours of daylight and darkness about the same?*

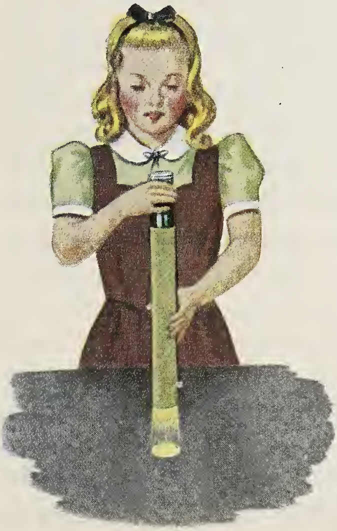
Why are summer days warmer than winter days?

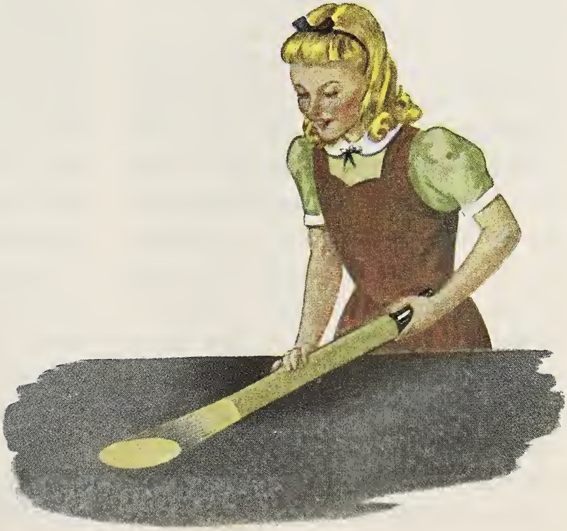
Summer days have more hours of daylight than winter days. They are different in another way, too. Summer days are much warmer than winter days. Can you think of one reason why this is true? You know that the sun gives us light and heat. The longer the sun shines on our part of the earth, the longer we get heat from the sun. So, in summer, we get more heat from the sun.

In winter, there are fewer hours of daylight. So the hours of darkness are longer. The sun does not shine on our part of the earth for so many hours. So the earth gets less light and heat from the sun, and the days and nights are cold.

There is another reason why the days are warmer in summer and colder in winter. It is because of the way the sun shines on the earth. The girl in the picture on this page is doing an experiment that will help you see why this is true. You can do the experiment, too, if you have a flashlight and a cardboard tube or some heavy paper.

Turn the flashlight on and put it inside the tube. Have the room as dark as possible. Hold the flashlight straight up and down above the table. Then slant it as the girl in the picture on the right is doing. Which spot is brighter, the larger one or the smaller one?



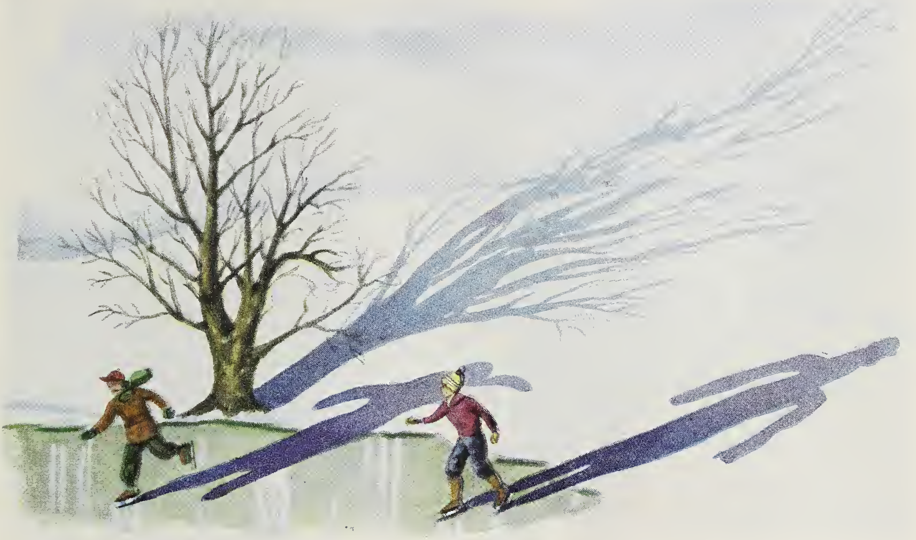


When the flashlight is slanted, the light is spread over a larger space than when it is held straight up and down. So the spot is brighter when the flashlight is straight up and down above the table.

Perhaps you have noticed that the sun is higher in the sky and straighter overhead during summer days than during winter days. There is an easy way to show that the sun is higher in the sky in summer than it is in winter. You know that when the light strikes you, your body makes a shadow. If it shines on you from nearly overhead, you make a short shadow. If it shines on you from lower down in the sky, your shadow is longer. So if you want to tell when the sun is highest, you can measure the length of your shadow at the same time of day in summer and in winter. Then you can tell when the sun is highest in the sky.

If you have ever watched your shadow as you walked under a street light at night, you understand how the length of a shadow changes. When the light is almost straight over your head, your shadow is short. If you walk away so that the light is not over your head, your shadow gets longer.

You do not need to be outdoors to see how shadows change. You can make them change right in your schoolroom by using a light for the sun and a yardstick to make the shadow. Set the yardstick up on one end. Then hold the light nearly above the yardstick. Is the shadow long or



short? Now move the light to one side of the yardstick. Does the shadow get longer?

In the picture on page 108, the children are swimming in a pond late on a summer afternoon. The children and the tree make short shadows. In the picture on this page, the children are skating on the pond at about the same time on a winter afternoon. See what long shadows the tree and the children make now. What does this tell you about the sun in winter? The sun is lower in the sky and not so straight overhead in winter.

The sun is straightest overhead in summer. So the earth gets more heat in summer. The earth gets the most heat when the sun is straightest overhead and when it shines the longest. So the days are warmer in summer than they are during the other seasons.

1. *Give two reasons why summer days are warmer than winter days.*
2. *How does your shadow tell you when the sun is straightest overhead?*
3. *During which season of the year will shadows be the shortest? During which season will they be longest?*

This girl is looking at a sundial. Find out how sundials are used for telling time.

QUESTIONS TO ANSWER

1. Why have people changed their minds about what makes day and night?

2. Which of these things did people need to know before they could understand why summer is warmer than winter? Explain your answer.

a) The earth goes around the sun.

b) The days are longer in summer than in winter.

c) The sun is straighter overhead in summer than in winter.

d) The earth turns on its axis.

e) The sun is far from the earth.

f) The earth gets the most heat when the sun is straightest overhead.

3. How does the change in the hours of daylight and darkness make a difference to baseball players, farmers, drivers of milk wagons, and boys carrying newspapers?

4. Think of as many things as you can that would happen on the earth if the sun did not shine at all.

5. How do you know that the earth turns on its axis from west to east?

6. About how many times has the earth turned around on its axis since you were born?

7. Why is it important for the men who run railroad trains to know exactly what time it is?

THINGS TO DO

1. Ask a jeweler how he finds out the correct time. How often does he get the correct time?

2. Lay a sheet of paper where the sun will shine on it all day. Have the long way of the paper pointing north and south. Stick a pin straight up and down in the paper at the south edge. Draw a line right on the shadow. Keep on drawing lines along the shadow every hour. How does the length of the shadow change? Can you tell about what time of day it is in this way?

3. Measure your shadow in the morning, then at noon, and again in the late afternoon. Explain what you find out.

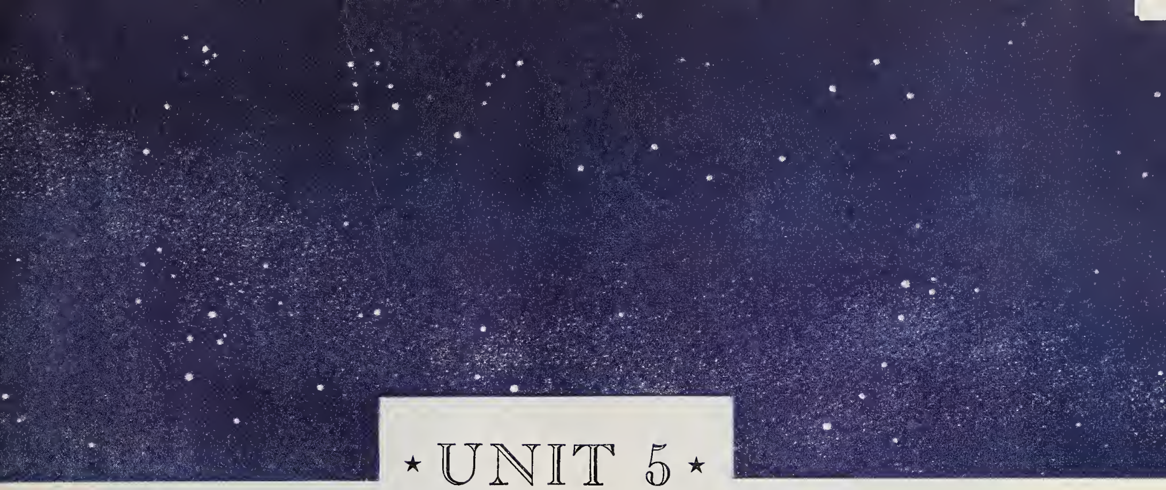
4. Find out how people told time before they had clocks. Find out whether people still use any of these ways of telling time.

5. What day of the year has the most daylight? What day of the year has the least daylight?

6. Find out what two days of the year have exactly the same amount of daylight and darkness.

⋆ *Unit Five Will Tell You* ⋆

⋆ *What a star is* ⋆ *What a constellation is* ⋆ *Why the constellations seem to move* ⋆ *How the moon is different from the stars* ⋆ *What the moon is like* ⋆ *Why the moon seems to change its shape* ⋆ *What a planet is* ⋆ *What a shooting star is* ⋆



⋆ UNIT 5 ⋆

What Can We See in the Sky at Night?

Have you ever seen a sun at night? Of course you have. You have seen hundreds of suns. You have seen so many suns at night that it would take you a long time to count them. Does this seem strange to you?

In the daytime you see only one sun. It is the great hot ball of glowing gases that gives us heat and light. But at night, if you look up into the sky, you can see hundreds of shining, twinkling suns.

What is a star?

You have always called these twinkling suns *stars,* and they are stars. But they are suns, too. Suns and stars are the same. Each star is a big ball of glowing gases. These gases are very, very hot, just like the gases in our sun. They give light, just as the hot gases in our sun do. It is this light that you see up in the sky at night.

Perhaps you wonder why these stars do not look like our sun. It is because they are so far away. They are hundreds and thousands of times as far away from the earth as our sun is. You know that automobile lights look like tiny dots when they are a long way down the street. As they come closer, they look larger and larger.

If these far-off stars should come as close as our sun, they would look larger, too. Many of them are much larger than our sun. Some of them would almost cover the whole sky

This bar of steel has been heated until it gives off a yellow light.

if they were as close to us as our sun is! If our sun were as far away as any of the other stars, it would look like a tiny point of light.

If you have ever looked closely at the stars, you may have noticed that they are not all the same color. Some are reddish, some are yellowish, and some are bluish-white. If you try this experiment, you can explain why the stars have different colors.

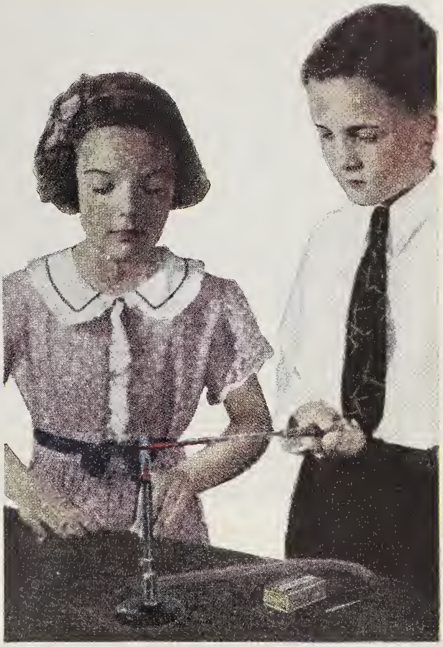
Find an old steel knitting needle or a piece of iron wire about a foot long. With a pair of pliers hold the steel or iron in a very hot flame. Keep it in the flame and watch the color of the steel or iron change.

Before you put the metal into the flame, it is cold. It does not give off any light or heat. Soon after you put it into the fire, it begins to get red-hot. It gives off a red light. As you keep heating the metal, it gets hotter and hotter until it is yellow. Then it gives off a yellow light. When the metal is yellow, it is hotter than it was when it gave off the red light.

If you could heat the steel or iron still hotter, it would get so hot that it would give off a bluish-white light. It would then be very, very hot. Perhaps you can see now why stars have different colors. Some stars are much hotter than others. Now when you look at the stars, you can tell the hottest stars from the stars that are not quite so hot.

You know from your experiment with the metal that red stars are hot. But they are not so hot as some of the others. Have you found yellow stars in the sky at night? They are hotter than the red stars. There are other stars in the sky that give bluish-white light. You know that they are hotter than either the red stars or the yellow stars.

Perhaps tonight you may look up at the sky and see a star that is bluish-white. You may say to yourself, "That is a very, very hot star. It is hotter than the yellow stars and much hotter than the red ones."



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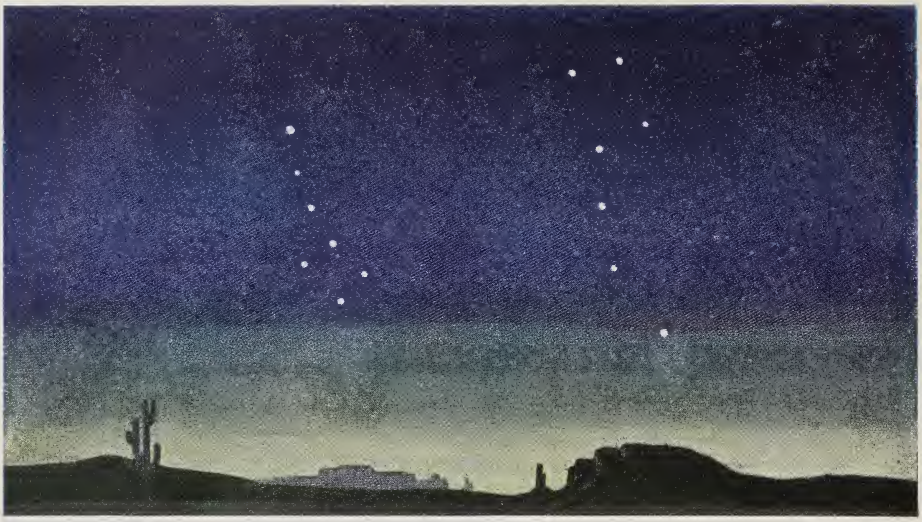
1. *How is our sun like the other stars?*
2. *Is the star that we call our sun as hot as a bluish-white star? Is it as hot as a red star? How do you know?*
3. *Why does the sun give light?*
4. *Some of the stars are larger than our sun. Why do they look smaller than the sun?*
5. *List the colors of the stars, beginning with the hottest stars.*

What is a constellation?

Suppose you go outdoors tonight and look at the stars. Soon after the sun goes down, they begin to come out. At first, you see only a few stars. As it gets darker, you see more and more of them. At last, the whole sky seems to be filled with hundreds of shining points.

Look closely, and you may see that some of these stars look as though they are grouped together. One of these groups of stars has the shape of



a huge dipper. You can find it easily if you face toward the north and look up at the sky. You will see the bowl of the dipper and the long, curved handle. This group of stars is called the *Big Dipper.*

Look near this dipper in the northern sky, and you may see a group of stars that has the shape of a smaller dipper. You can see the two dippers in the picture at the top of the page.

Scientists call a group of stars a *constellation.* The constellations, or groups of stars, have names. The Big Dipper is part of one of these groups of stars. It is part of a large constellation called *Ursa Major.* Ursa Major means Big Bear.

The constellation that looks like a small dipper is usually called the *Little Dipper.* The Little Dipper is also called *Ursa Minor,* which means Little Bear.

You are probably wondering why a group of stars is called Ursa Major, or Big Bear. For hundreds of years people have watched the stars and studied the constellations. The shepherds of long ago discovered these star groups as they watched over their sheep on the hillsides. The sky was almost the only thing the shepherds had to look at through the long nights. They wondered what the stars were and how so many of them came to be up in the sky.

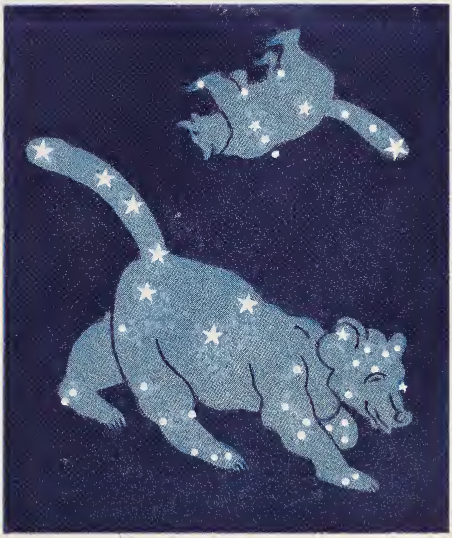
The shepherds made up stories about these constellations as they watched the starry sky night after night. They imagined that some of the groups of stars had the shapes of animals. They thought other groups made pictures of kings or queens or hunters. The Indians made up stories about these groups of stars, too. The stories about the constellations are very, very old. Today we know that they are not true, but people once believed them. We still use the names that the people of long ago gave to the groups of stars.

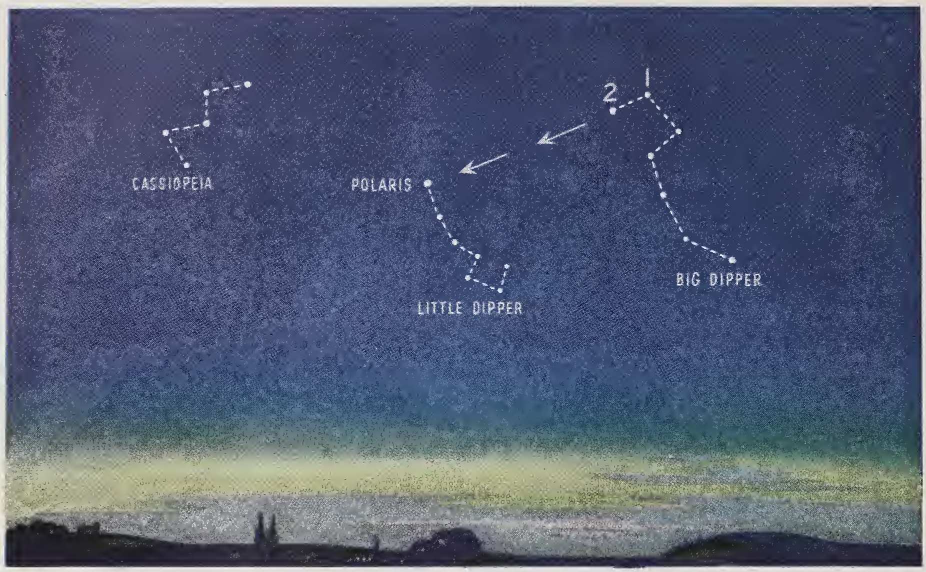
One of the most interesting stories is about the constellations of Ursa Major and Ursa Minor. It tells about a princess who once lived on the earth, and about Jupiter, the king of the gods, who lived in the sky. The queen of the gods became very angry with the princess. So she had the princess changed into a bear.

One day when the son of the princess was hunting, he came upon this bear in the woods. The prince did not know that the bear was his mother. He was just going to kill the bear when Jupiter stopped him. Then Jupiter changed the young man into a little bear, took him by the tail, and threw him into the sky. After that, Jupiter took the big bear and threw her up into the sky near her son.

Now you can understand how one constellation came to be called Ursa Major, or Big Bear, and why the other constellation came to be called Ursa Minor, or Little Bear. Ursa is an old, old word for bear. Major means large, and minor means small. Look at the picture on this page. It shows how people thought they could see the shapes of two bears in the sky. Do you see that the handle of the Big Dipper makes the tail of the Big Bear? What part of the Little Dipper makes the tail of the Little Bear? You may have to turn the picture upside down to see the Little Dipper clearly.

There are seven bright stars in the group of stars called the Big Dipper. In the early evening in February and March you will find the Big Dipper standing on its handle in the northeastern sky. Four bright stars make the bowl of the Big Dipper, and three bright stars make its handle.





The constellations are in the positions shown in this picture about 8 o'clock in the evening during the month of March.

Look at the picture on this page and find the stars at the front of the bowl. They are numbered 1 and 2. These stars are very important ones to know. They will help you tell which direction is north, and they will also help you find other constellations in the sky. They are called the *pointers.* If you draw a line from 1 to 2 and then draw the line on across the sky, you will see that it points toward another bright star. This star is called the *North Star. Polaris* is another name for the North Star.

When you look toward this star, you are looking north. It is called the North Star because it is always in the north. Sometimes the North Star is called the *Pole Star* because it is almost straight above the earth's North Pole. Scientists usually call the Pole Star Polaris.

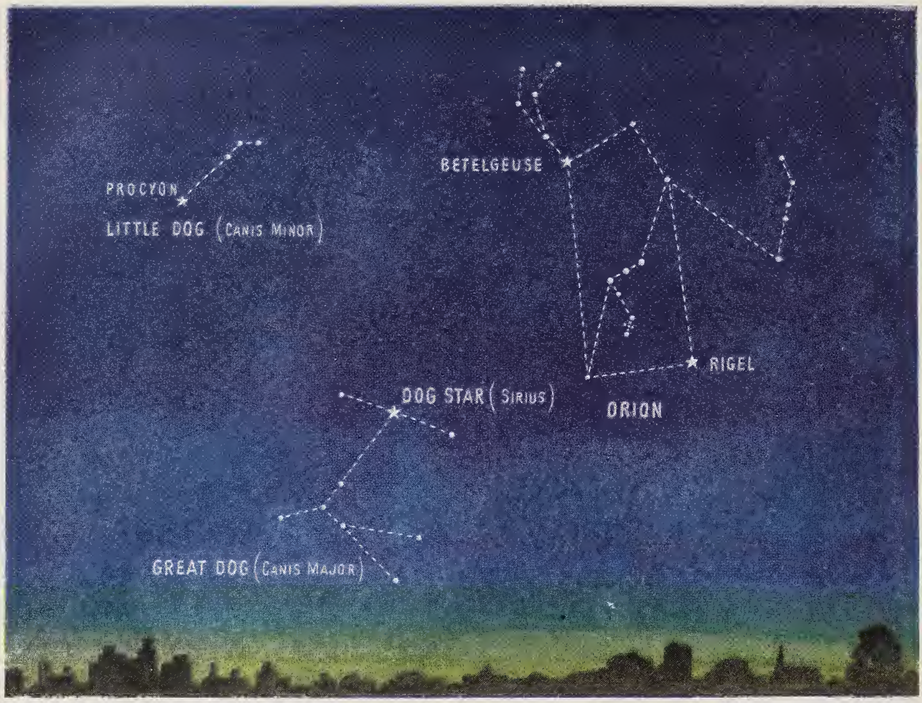
The constellation of the Little Dipper is easy to find if you have learned to find the North Star. The North Star is at the end of the handle of the Little Dipper. Study the picture and see how easy it is to find the Little Dipper after you have found the North Star. There are seven stars in the Little Dipper, just as there are in the Big Dipper. But they are not nearly so bright as the stars in the Big Dipper.

Find the Big Dipper in the picture on page 116. Find the North Star and the Little Dipper. On a clear night you can find them in the sky just as you have found them in the picture.

After you have learned to find the Big Dipper and the Little Dipper, you will want to find other groups of stars. Another constellation that is easy to find is the group of stars that looks like a W. The W is made of five bright stars. This constellation is called *Cassiopeia*, the name of a queen of long ago. Sometimes it is called Cassiopeia's Chair. In the picture you will see that the letter W makes a chair for the queen.

So far, we have looked only at the stars toward the north. Now let us turn around and see what we can find in the southern part of the sky. Here we find a constellation that has some of the brightest stars in the sky. It is called *Orion.*

Long ago, people thought that this group of stars had the shape of a mighty hunter. They named it Orion after a famous hunter in their stories. They imagined that the hunter in the sky had a belt with a shining sword hanging from it. In his right hand they thought he held up a big club.



During the winter months face south, and you can easily see Orion. Perhaps you can find the dogs, too.

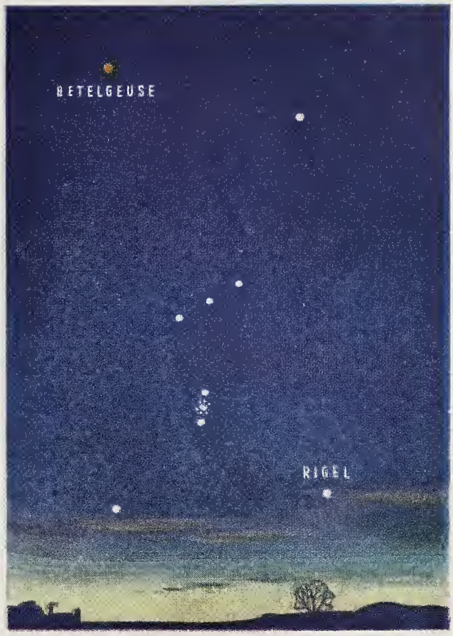
On his left arm he held a lion's skin for a shield. Behind the hunter were his two dogs. In the picture on this page you will find the two constellations that make the dogs. What are the names of these constellations? What is the name of the brightest star in each constellation?

Orion is a large constellation. It has more bright stars than any other constellation. To find Orion, look in wintertime toward the south until you see three bright stars in a row. These stars are Orion's belt. Find them in the picture. Just below them are a few small stars close together. They show where the sword hangs from the hunter's belt. Below the belt and a little to the right is a large, bright star. This star is called *Rigel*. It shows the lifted knee of Orion. There are only six stars in the sky that are brighter than Rigel.

Now look above the belt and a little to the left, and you will see another large, bright star. This one is called *Betelgeuse*. It marks Orion's shoulder. Betelgeuse is a very big star. It is many, many times as large as our sun. It is a good thing for us that Betelgeuse is very far away from the earth, because it would very quickly burn us up if it were as close to us as the sun is.

You can be sure that you have found Betelgeuse and Rigel if you will notice their colors. Rigel is bluish-white, while Betelgeuse is reddish in color. Can you tell which of these stars is hotter?

If you are out looking at the constellations on a very clear night, you will probably see something that looks like a bright pathway of light going from north to south across the sky. This is the *Milky Way*. It is called the Milky Way because it looks as if someone had spilled a pail of milk across the sky. But scientists know that the Milky Way looks so bright because it is made up of many, many millions of stars that are giving off light. Look at the picture at the beginning of this unit. Can you find the Milky Way?



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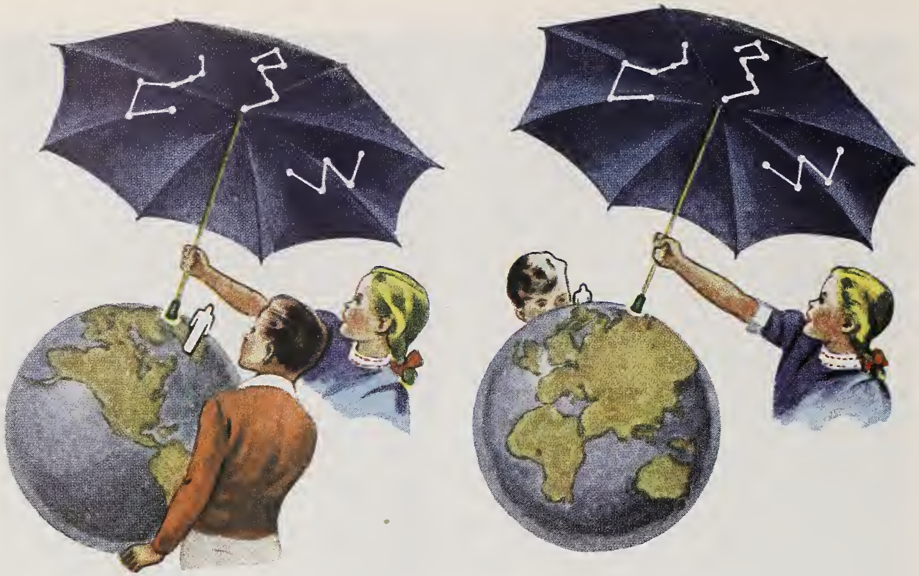
1. *Name four constellations and tell how you would help someone find them.*
2. *Draw the Big Dipper and show how to find the North Star by using the pointers.*
3. *Draw the constellation Orion on the blackboard and tell the names of the brightest stars in it.*
4. *Which constellations that you have learned about are in the southern sky? Which are in the northern sky?*
5. *Write three things you have learned about each of these.*

Constellations *The North Star* *Orion*



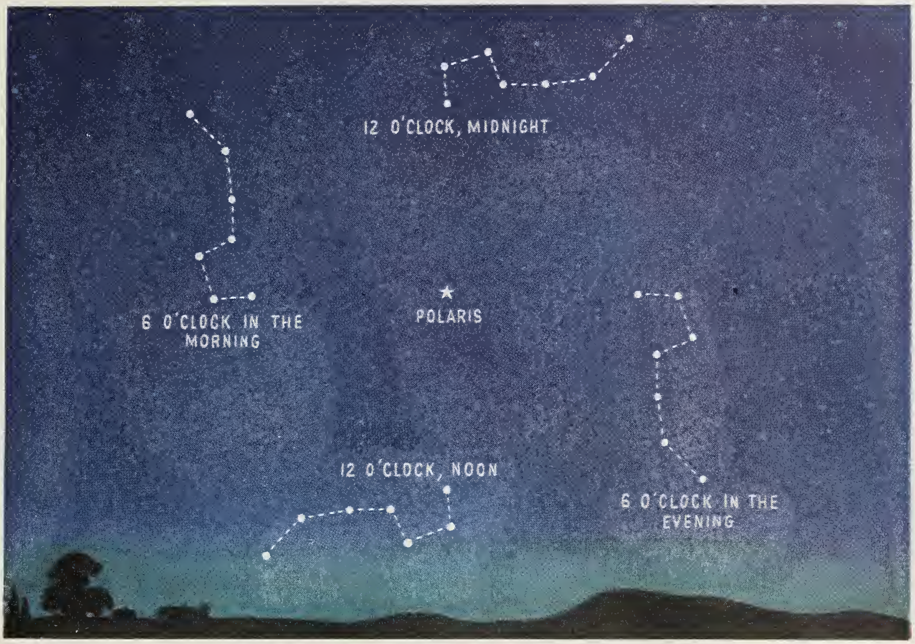
Why do the constellations seem to move?

ON SOME CLEAR NIGHT, as soon as the stars are out, notice just where Orion is in the sky. Then just before you go to bed look at this constellation again. Was Orion farther toward the west the second time you saw it? If you stayed up much later to see Orion, you would not find it. It would be out of sight!

The same thing happens when you are watching the sun. You know that we first see the sun in the east, and at the end of the day we see it disappear in the west. But the sun does not move around the earth, nor do the stars. We see the star groups in different places at different times because the earth turns on its axis.

You can see why this is true if you will do this experiment. On the underside of a dark blue or black umbrella paint the Big Dipper, Little Dipper, and Cassiopeia. Use the picture at the top of this page to show where to put these constellations. Put the North Star against the rod that goes through the center of the umbrella.

Have one of your classmates hold the handle of the umbrella on the globe at the North Pole. Be sure that the globe will turn but the umbrella will not. Then cut out a little cardboard boy and paste it on the globe so that it is standing near the place where you live.



The Big Dipper can be used as a clock because it seems to move around Polaris. But the Dipper moves in the opposite direction from the hour hands on a clock. The stars are in the positions shown in the picture about the first week in March.

Now stand beside the globe where the cardboard boy is pasted and look up at the umbrella sky. Is the Big Dipper at the right or at the left of the North Star? Turn the globe slowly about halfway around and follow the cardboard boy. Is the Big Dipper now at the right or at the left of the North Star?

The experiment shows that when the globe is turned, the stars are seen in different parts of the sky. If the globe did not turn, the stars would be found in the same part of the sky.

---

1. *Does the experiment show that the constellations change their positions because they are moving or because the earth is moving?*
2. *What does the picture on this page show?*
3. *How can you tell from the picture that the Dipper moves in the opposite direction from the hour hands on a clock?*

The small "lights" down the middle of the road are really pieces of metal that reflect the light from the automobile headlights. The metal marker at the side of the road reflects light, too. Smooth, light-colored materials reflect more light than dark, rough ones.

How is the moon different from the stars?

While you have been watching the stars, you must have noticed something else in the sky. It shines brighter than anything else in the sky except our sun. Of course, it is the *moon*. The moon is nearer to us than any of the stars. It is only about 240,000 miles from us, while the sun is 93 million miles away.

The moon is round like a ball. But it is not hot like the sun and the stars. So it cannot give off its own light. Do you know how we can see it even if it does not give off its own light?

Have you ever driven along a country road at night and noticed the signs that shine when light from your automobile strikes them? These signs that read "Stop" or "Curve" are often made with little pieces of metal or glass. At night, the light from your car shines on the signs, and they glow as if they had electric-light bulbs on them.

If you hold a mirror so that the sunlight strikes it, you can make a bright spot of light on the wall. The mirror seems to be making its own light.

But the road signs and the mirror have no light of their own. We say that they *reflect* light. Reflect means throw back. The signs reflect the light from the automobile. The mirror reflects the light of the sun.

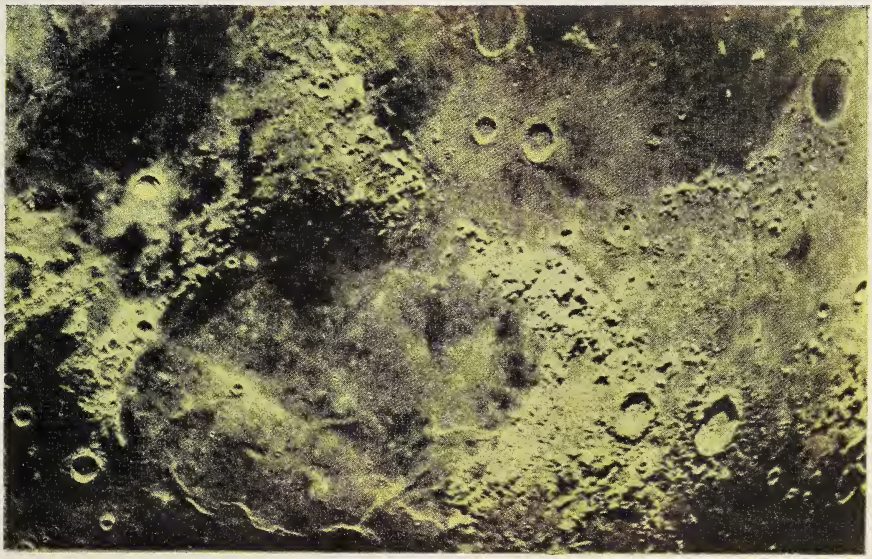
The moon reflects light in the same way. Light from the sun strikes the moon, and the moon reflects the light. We see the moon because the light from the sun is reflected from the moon to us.

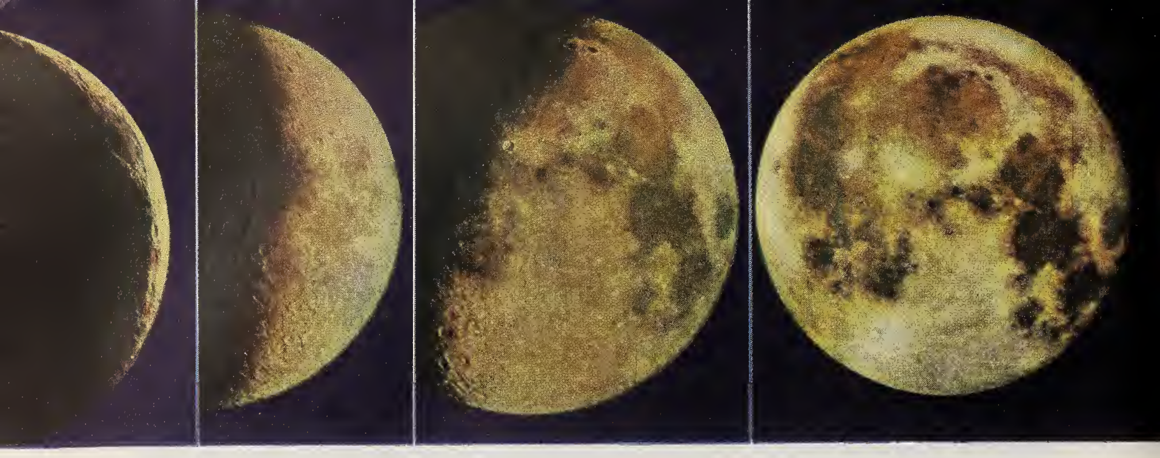
1. *What does* reflect *mean?*
2. *How is the moon different from a star?*
3. *Why is moonlight really sunlight?*
4. *Why do the pieces of metal in the road look brighter than the road?*

What is the moon like?

Did you ever see "the man in the moon"? Of course, we know that the face on the moon is really not a face at all. But do you know what it is? Let us see if we can find out.

If you went for a long hike on the moon, you would find it very rough walking in many places. There are long ranges of mountains with deep valleys. And there are big holes in the





If you watch the moon every few days for a month, you will see that it has these shapes. The thin slice that you see first is usually called the new moon. When it is round, it is called the full moon.

tops of some of the mountains. On some parts of the moon there are long, level plains.

On page 125 is a picture of the moon. You can see mountains, valleys, and plains. When light from the sun strikes the moon, these mountains make big, long shadows. We can see these shadows. We like to imagine that they make the face of a man. We call this man the "man in the moon."

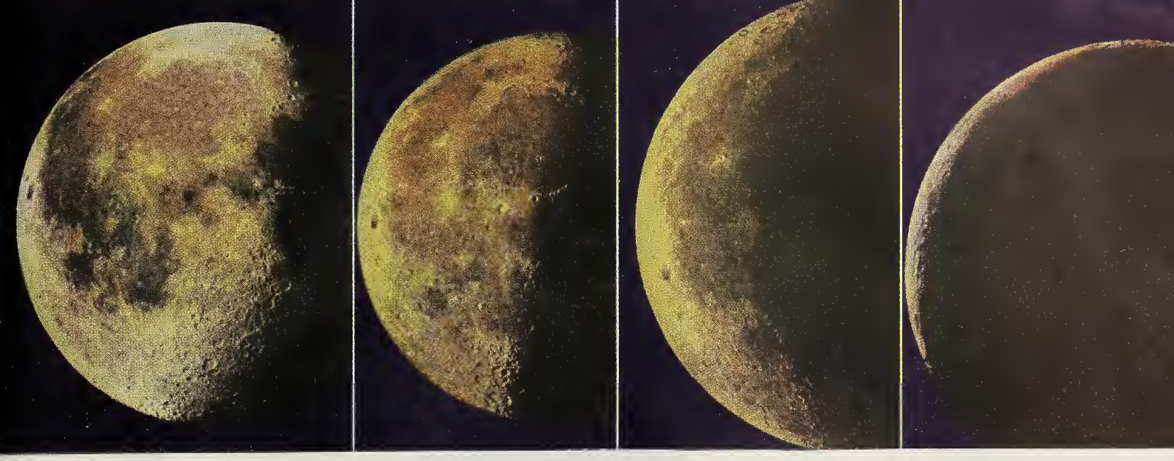
Scientists have studied the moon with huge telescopes like the one on page 134. Telescopes make the moon look nearer and larger. Sometimes a scientist puts a camera on the telescope and takes pictures of the moon. The picture of the moon on page 125 was taken this way. That is why you can see the mountains and valleys so plainly. Scientists have given names to many of the mountains, valleys, and plains. They have even made maps of the moon.

Even if you could get to the moon, you could not live there. Do you know why? If you remember what you learned in Unit Two, you will understand why. There is no air on the moon. So, of course, there would not be any oxygen for you to breathe. There is no water, either. With no air and no water, you could never live there. There are no living things on the moon.

---

1. *Why are there no living things on the moon?*
2. *Why do we see shadows on the moon?*
3. *Which of these things are on the moon?*

Trees *Mountains* *Lakes* *Birds* *Shadows*



These pictures show how the moon looks after it has been full and round. The thin slice that we see last is called the old moon. For a few days before the next new moon, we cannot see the moon at all.

Why does the moon seem to change its shape?

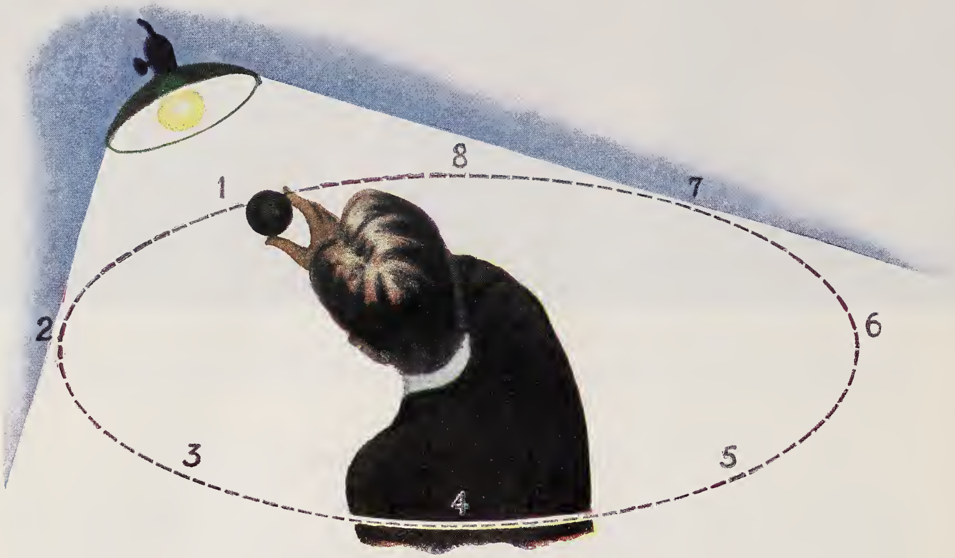
As you watch the moon, you notice that it does not always seem to have the same shape. Sometimes it looks thin and curved, like the first picture on page 126. Then on the following nights it seems to grow larger and larger. In about two weeks it looks round. What happens then? Look at the pictures on this page and see what happens after it looks round.

You have often seen the moon when it has the different shapes shown in the pictures. Let us see if we can find out why the moon seems to have these different shapes each month.

You know that the moon does not give its own light. We see it because it reflects sunlight. You remember that the sun always lights half of the earth. The sun always lights half of the moon, too. But from where we are on the earth, we cannot always see all of the lighted part of the moon. Sometimes we cannot see any of the lighted part.

When we cannot see the moon at all, we are looking at the side that is not lighted. Scientists call this dark side of the moon the *new moon.* But we usually call the first part that we can see each month the new moon. This is just a thin slice of the lighted part.

When we see half of the lighted part, we say that the moon is half full. Or we call it a *half moon.* When we can see all of the lighted half, the moon looks round to us. We call it a *full moon.* At the end of the month we again see only a thin slice of the lighted part. This is called the *old moon.*



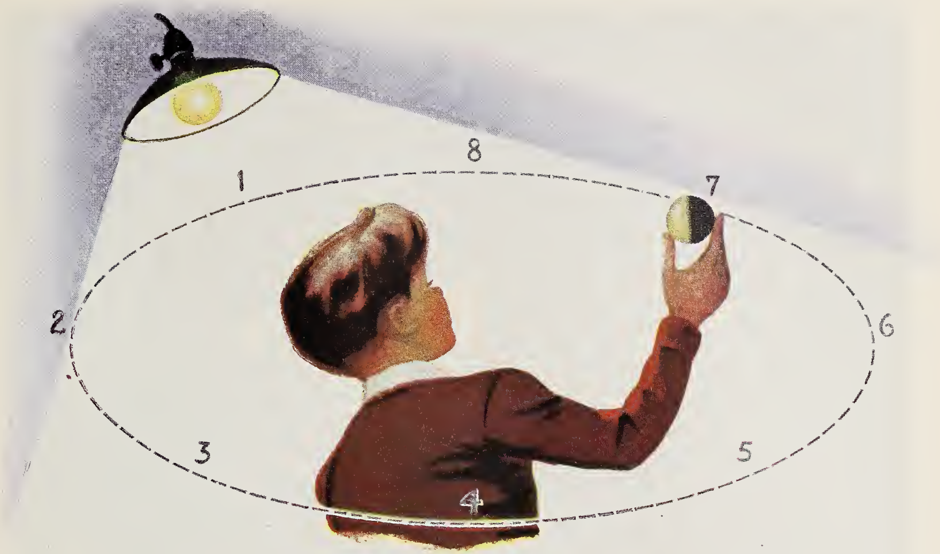
Perhaps you can understand this better if you do an experiment. Get a bright light. Place or have someone hold the light as shown in the picture. Imagine that this light is the sun. You are the earth. Hold a small ball like a tennis ball at arm's length from you.

The ball is the moon. Stand with your face toward the light and hold the ball between you and the light as the boy in the picture on this page is doing. Is all of the ball lighted? Can you see the part that is lighted?

Now turn slowly around and stop at each one of the numbered places. Can you always see all of the lighted part? Draw pictures of the lighted parts that you can see. Compare your pictures with the pictures on pages 126 and 127. Do they show the same shapes as the lighted parts in the photographs of the moon?

Try to find a calendar that has the different shapes of the moon on it. The new moon will be shown as a black ball or as a very small part of the moon. As the days of the month pass, we can see more and more of the moon. At last, the moon will be round and full. Then the lighted part will slowly get smaller and smaller again.

The shapes of the moon are put on the calendar to show you when the moon is full, when you can see only part of it, and when you cannot see it at all.



The Indians did not have calendars. They used the moon to tell how much time had passed. The moon goes through its changes in shape once in about twenty-eight days, or about four weeks. This is almost a month. As you know, there are twelve months in every year. The Indians used to call a month a "moon." To tell about a long journey that took many months, they might say, "We traveled for many moons."

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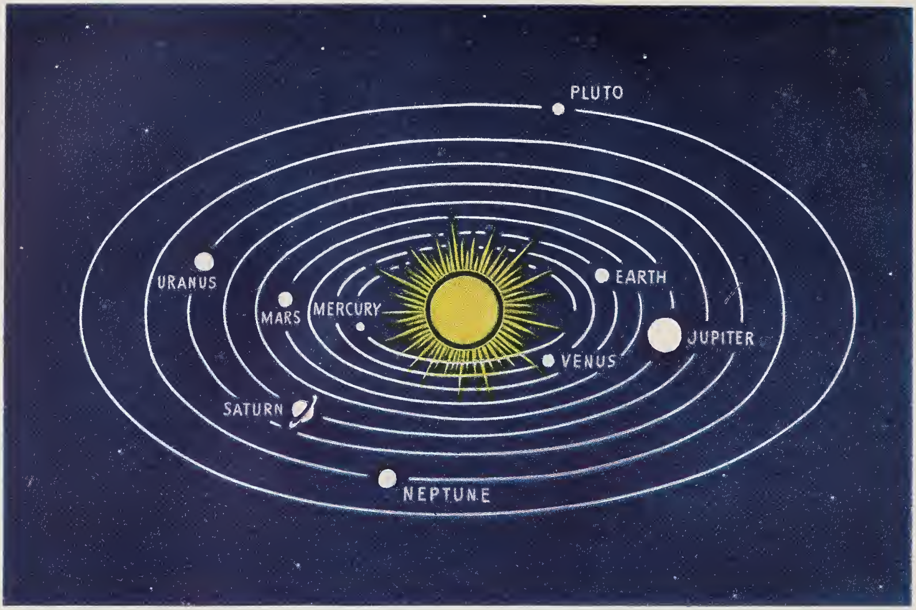
1. *What does the experiment show you about the moon?*
2. *Which sentences below describe the moon? Which sentence describes a star?*
    - a) *It reflects light from the sun.*
    - b) *It is a hot ball of gas.*
    - c) *It seems to change its shape.*
    - d) *It is closer to the earth than any of the stars.*
    - e) *It has deep valleys and high mountains.*
3. *How long does it take from one new moon to the next one?*
4. *Look at a calendar that has the shapes of the moon on it. On what date is the moon full this month? On what date is it new next month?*



As the planets travel around the sun, each planet always stays in its own path.

What is a planet?

If you look up into the sky at night, you may see other lights that are not stars. Like the moon, they do not give off light of their own. They reflect light from the sun just as the moon does. These other lights you may see in the sky at night are called *planets*. Planets look like stars, but they are really quite different. All planets travel around the sun, but no stars do. A planet does not give off light of its own as a star does.

There are millions of stars, but there are only nine *known* planets. We say *known* planets, because until a few years ago scientists thought there were only eight planets. Then they found another planet. Perhaps, as scientists watch the sky, they may find still more planets. Almost every day scientists discover something new about the world we live in.

How would you like to live on a planet? You may be surprised to learn that you do live on one. The earth is one of the nine planets. It does not give off its own light. And it travels around the sun, as you know. Two of the planets are closer to the sun than the earth is. Study the picture on page 130 and tell which planets they are. Six of the planets are farther from the sun than the earth is. Find the names of these six planets.

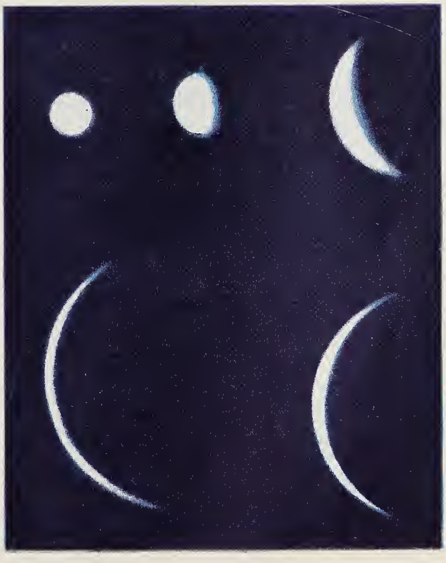
The planet nearest to the sun is called *Mercury*. You remember that it takes our planet, the earth, a year to travel around the sun. A year on the other planets is the time it takes these planets to travel around the sun, too. Some of the planets are nearer to the sun than the earth is. It does not take them so long to travel around the sun. Their year is shorter than ours. Some are farther away from the sun than the earth is. Their year is longer than ours. Mercury is so close to the sun that it has a much shorter journey around the sun. Its year is only eighty-eight days long. How many days are there in our year?

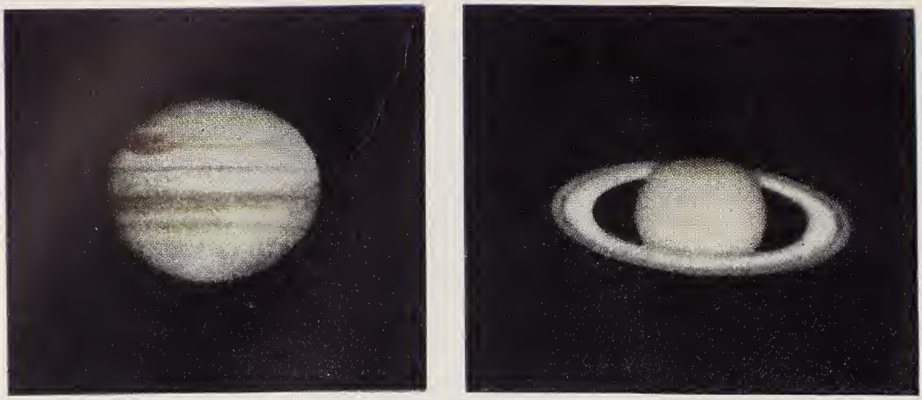
The planet next to Mercury in nearness to the sun is *Venus*. Venus takes 225 days to go around the sun. There are only two things in the sky that are brighter than Venus. Do you know what they are? One is the sun. The other is the moon. Venus is the third brightest. When you see it in the sky at night, you may think that it is the bright light of an airplane.

Venus is a beautiful planet. You can sometimes see it in the western sky just after sunset. Then it is called the "evening star."

You have probably heard people talk about the "evening star" or the "morning star." These "stars" are really planets that can be seen after sunset or before sunrise. Sometimes Venus is an "evening star." At other times, Venus is a "morning star." You would have to get up before sunrise to see it.

Venus is sometimes called the earth's twin, because it is almost the same size as the earth. Scientists cannot find out what Venus is really like, because there are so many clouds around it. But scientists do know that Venus seems to change its shape, just as the moon does. The picture on this page shows how Venus looks at different times.





The planet on the left is Jupiter. The picture on the right shows Saturn and its rings.

Farther out from the sun is *Mars.* It is farther from the sun than Mercury, Venus, and the earth are. Mars is much smaller than the earth. The earth would make six planets the size of Mars. But the year on Mars is almost twice as long as the earth's year, because Mars is farther away from the sun and takes more time to travel around it. Mars looks red.

Next beyond Mars comes *Jupiter,* the largest of all the planets. It is still farther away from the sun than Mercury, Venus, Earth, and Mars. Jupiter is larger than all of the other planets put together. It is about a thousand times as big as the earth. Jupiter is so far away from the sun that it takes almost twelve of our years to travel once around the sun. If you lived on Jupiter, you would have only one birthday every twelve years!

Next beyond Jupiter, and still farther away from the sun, is a planet called *Saturn.* Saturn is a very beautiful planet to see through a telescope. Study the picture of Saturn on this page. Do you see how it is different from any of the other planets? It has rings. Sometime, when you learn more about Saturn, you will find out many interesting things about these rings.

Because Saturn is still farther away from the sun than Jupiter is, it has even a longer year than Jupiter. It takes Saturn nearly thirty of our years to go around the sun once.

After Saturn we come to *Uranus* and then *Neptune.* It takes Uranus eighty-four years to go around the sun. The year on Neptune is almost 165 times as long as our year on earth. Farthest away from the sun of all is a planet that was discovered only a few years ago. Its name is *Pluto.* Pluto is so far away from the sun that it takes 250 of our years to travel around the sun once. Pluto cannot be seen without the help of a telescope. It is so hard to see this planet that scientists know very little about it.

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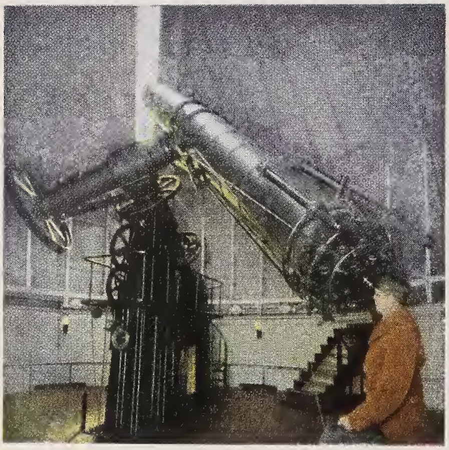
1. *In what two ways are planets different from stars?*
2. *Name the planets. Begin with the one closest to the sun and end with the one farthest away.*
3. *Why do we say, "There are nine* known *planets"?*
4. *Tell the name of the planet that*
    - *a) Is closest to the sun.*
    - *b) Has rings.*
    - *c) Is the brightest of the planets.*
    - *d) Is called the earth's twin.*
    - *e) Is farthest from the sun.*
    - *f) Is the largest planet.*
    - *g) Was discovered last.*

Are there living things on the planets?

HAVE YOU EVER wondered whether there are living things on any of the other planets? We are sure that there are living things on one of the planets. You know which one it is. It is the earth.

Even the wisest scientists do not know whether there are living things on the other planets. But they have found good reasons for believing that nothing could stay alive on most of them. Mercury is too close to the sun. It is so hot that a lead pipe would melt quickly on it. So scientists are sure that it would be too hot for anything to stay alive. Most of the other planets have no air on them. No one could live on these planets. Pluto and Neptune are so far away from the sun that they are colder than anything that we know on earth. It is always very, very cold on these planets.

For a long time people have been very much interested in Mars. They think that there may be living things on it. With their giant telescopes scientists have studied Mars. They have seen great lines that look like ditches or canals. No one is sure what these lines really are. But some scientists think that they might have been made by people.



The picture on the left shows a huge telescope. The other picture shows what Mars looks like when seen through a telescope like this.

Perhaps some day scientists will find that there are living things on Mars. This planet seems to have some kind of air, so that living things might be able to stay alive on it. Mars has seasons. At certain times, parts of the planet look green. Some scientists believe that there may be some kinds of plants growing on Mars. But no one has been able to prove that this is true. Other scientists think there are probably no living things on Mars.

---

1. *Why is it very cold on Pluto and Neptune?*
2. *Why do some people believe that one of the planets besides the earth may have living things on it?*
3. *What two materials must a planet have before it can have living things on it?*

What are shooting stars?

As you watch the stars, the planets, and the moon, you may see something else in the sky. You may be looking at the Big Dipper or Cassiopeia when suddenly a bright flash shoots across the sky and disappears. It looks like a giant skyrocket though it seems to be far away. You probably say, "Oh! Look at the shooting star."

We call them "shooting stars" or "falling stars," but they are not really stars. They are solid objects traveling through the sky. Whenever the moving earth comes near them, they rush toward the earth. When they reach the ocean of air around the earth, they start glowing. Then we can see them. Scientists call a shooting star a *meteor*.

Meteors travel toward the earth at great speed. They give off light just as any very hot thing does. We look up into the sky and see a bright flash. As we watch, this light disappears. Do you know what has happened? The meteor has burned up, or perhaps it has hit the earth somewhere. The part of the meteor that falls to the earth is called a *meteorite*. The picture on this page shows a meteor.

If the meteorite is very large, it may go deep into the earth. But most meteors break into little pieces or burn up before they strike the earth. Some meteorites are made of rock, and some are made of iron. Others are made of a mixture of iron and rock.

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1. *How are shooting stars different from real stars?*
2. *What are meteors made of?*
3. *When a meteor disappears, what becomes of it?*
4. *Have any shooting stars ever fallen near where you live?*

This large meteorite that fell in the state of Oregon is made of iron and other metals. Most meteorites are much smaller than this one.

QUESTIONS TO ANSWER

1. How do scientists learn new things about the sun, moon, stars, and planets?

2. Which of the things you can see in the sky
   - *a*) is most like the earth?
   - *b*) seem to change their shapes?
   - *c*) give the earth light?
   - *d*) gives the moon light?
   - *e*) warms the earth?
   - *f*) travel around the sun?

3. Why is it important to know about the North Star?

4. Tell what you have learned about each of these: Venus, The Big Dipper, Mars, Betelgeuse, reflect, the moon, Pluto.

5. How did people first happen to think of stars as being in groups?

6. Why is moonlight not so bright as sunlight?

7. Why do we not see the stars in the daytime?

8. If you were lost at night, how could you use the stars to help you find your way home?

THINGS TO DO

1. Look at the full moon with field glasses and see if you can find plains, valleys, and mountains on it.

2. Read some stories about constellations that are not given in this book.

3. Make a chart showing the pictures of the constellations you can find as you face north.

4. Make a chart showing the pictures of the constellations you can find as you face south.

5. Keep a record on a calendar of the different shapes of the moon as you watch it for a month.

6. Learn to find Mars, Venus, Jupiter, and Saturn during the months when they can be seen.

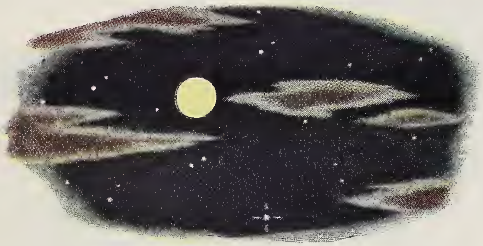
7. Look at the stars and try to find ones that have different colors.

8. Look for pictures of meteorites.

9. Use different ways to show the constellations you know. Here are two ways you can try.

   a) Get a large piece of blue cardboard. Cut holes in the positions of the stars in each constellation. Put Christmas-tree lights in the holes.

   b) Cut holes in blue paper to show the positions of the stars in each constellation. Slip the paper into the open end of a box. Then hold an electric-light bulb or flashlight inside the box.



★ *In Unit Six You Will Learn* ★

★ *What kinds of magnets there are* ★ *What kinds of things a magnet will pick up* ★ *What kinds of materials the force of a magnet will pass through* ★ *What the poles of a magnet are* ★ *How magnets act toward each other* ★ *Why a magnet points toward the north and the south* ★ *How you can make and use a compass* ★

★ UNIT 6 ★

What Can Magnets Do?

ONE DAY BILLY was having fun with a toy he had made. You can make the same toy if you do what he did. First, he put a straight steel bar called a *magnet* near the front of a small wooden boat. He tied the magnet to the boat so that it could not come off. Then he set the boat in a tub of water. The toy was ready for use.

Billy picked up another straight steel bar like the one on the boat. This bar was a magnet, too. He held one end of it close to the front end of the magnet on the boat. Like magic, the boat moved toward his hand! Billy pulled his hand away slowly, and the boat followed. He made it sail all around the tub of water.

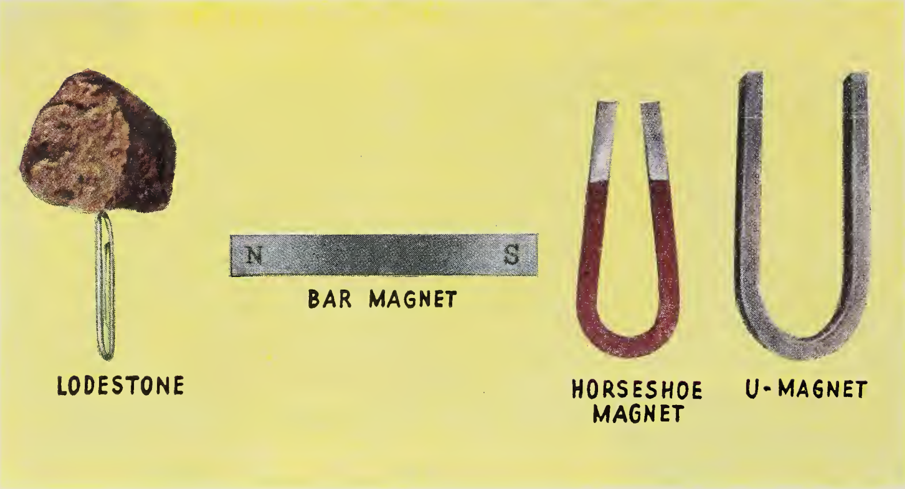
"I wonder what will happen if I hold the other end of this magnet near the front of the boat," Billy said to himself. "I'll try it and see."

Do you know what happened this time? Instead of moving toward his hand, the boat moved away!

"That's funny," Billy thought. "This end pushes, and the other end pulls. The ends of this magnet must be different."

Do you think he was right?

In this unit you will learn several very important things about magnets. As you study magnets, you will understand how one end of the magnet pulled the boat and the other end pushed it. You will find out other interesting things about magnets, too.



What kinds of magnets are there?

Not all magnets are shaped like the ones Billy used. In the picture you can see some other kinds of magnets, too. What are the names of the others?

The magnets in the picture are made of iron or steel. Steel is a metal that is almost all iron. A few years ago all magnets were made of iron or steel. Then scientists discovered a new kind of magnet. This new magnet has in it three other metals besides iron. The metals are aluminum, nickel, and cobalt. This magnet gets its name *alnico* from the first two letters in each of those three words. An alnico magnet is very strong. It will pick up a piece of iron or steel many times as heavy as itself.

There is another kind of magnet. It is found in the ground, and you would never guess that it is a magnet. It looks like a rusty piece of rock, and it is called *lodestone*. Lodestone is a kind of rock that has iron in it. So it is a magnet, too.

No one knows who first discovered lodestone. Different stories are told about how it was found. One old story tells about a young shepherd named Magnes. While he was watching his sheep one day, he set his shepherd's staff down on a rock. The wooden staff had an iron tip on the bottom. When he tried to pick up his staff, the iron tip stuck fast to the rock. He had to pull very hard to get it away. He was so puzzled by what had happened that he told his friends about it. They called the rock a magnet from Magnes, the shepherd's name.

What kinds of things will a magnet pick up?

A MAGNET HAS no fingers, yet it can pick things up. Sometimes it can pick them up even better than you can with both hands. A magnet cannot think, yet it will pick up only certain kinds of things. And it never makes a mistake in the kinds of things it picks up.

You can find out what kinds of things a magnet will pick up by doing an experiment. Be sure to follow the directions carefully. If you are not careful when you do an experiment, you may make mistakes and not get the right answer.

Get as many of these things as you can: tacks, nails, needles, pins, a copper penny, a brass key, a rubber band, an eraser, pen points, paper clips, scraps of paper, bits of cardboard, pieces of iron, steel, wood, and chalk, some sand, something made of glass, and a silver dime. Also get some iron filings. These are tiny bits of iron that have been rubbed off by using a file on iron.

This small magnet is an alnico magnet.

Now get a magnet and see what things it will pick up. Make a list of all the things that the magnet picked up. Make another list of the things the magnet did not pick up. Did it pick up the tacks, nails, needles, pins, pen points, iron filings, and paper clips? Did it pick up the copper penny, the brass key, or the silver dime? The rubber band or the eraser? Paper or cardboard? Wood or chalk? Sand or glass?

Look at the list of things the magnet picked up. All the things in the list are made of metal. But the magnet did not pick up everything made of metal. It did not pick up the copper penny, the brass key, or the silver dime. If any of the pins or tacks were made of brass, the magnet did not pick them up.

Now look carefully at the list again. Do you see how all the things that the magnet picked up are alike in one way? They all have iron or steel in

The girl is using a magnet to pick up pins that might get into the vacuum cleaner.

them. As you know, steel is almost all iron. We call iron and steel *magnetic* materials, because a magnet will pick up things made of them. Iron and steel are the commonest magnetic materials. A magnet will pick up only things made of iron, steel, and a few other magnetic materials such as nickel and cobalt.

You found that a magnet will not pick up things made of copper, brass, rubber, paper, chalk, sand, wood, cardboard, or glass. All of these are called *non-magnetic* materials. Most materials are non-magnetic.

Did you notice that the magnet pulled things made of iron or steel toward it and then held them? When you wanted to take one of them off, you had to pull harder than the magnet was pulling. You could feel the pull of the magnet. This pull that the magnet has is called its *force*. We say, "A magnet *attracts* iron and steel." When we say this, we mean that a magnet pulls iron and steel toward it.

You probably found that the magnet does not have to touch a small piece of iron or steel to attract it. When you bring a magnet near a small piece of iron or steel, the piece jumps to the magnet. The force of the magnet makes the iron and steel move toward it.

Can you think of an experiment to show how far a magnet can attract a piece of iron? The boy in the picture on page 142 is doing one. He is slowly moving the magnet closer to the nail. Will the nail roll to the magnet? Try it and see. Use different kinds of magnets and find out which one has the most force. Also try different sizes of magnets.

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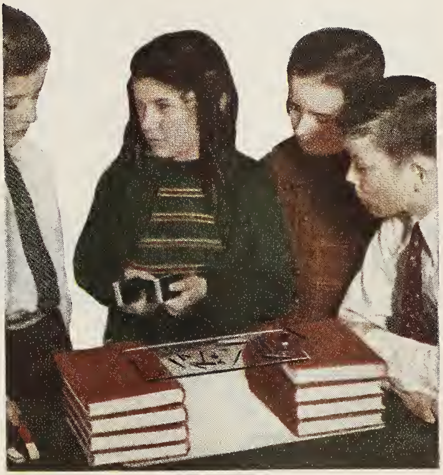
1. *Why should you be careful in following the directions for doing an experiment?*
2. *How can you find out whether a thing is made of magnetic material or non-magnetic material?*
3. *How do you know that a magnet has force?*
4. *What kinds of materials will a magnet attract?*
5. *Does a magnet have to touch a piece of iron to attract it? How do you know?*

What kinds of materials will the force of a magnet pass through?

YOU HAVE LEARNED that magnets attract iron and steel. But what can a magnet do to a tin can? Get a tin can and find out. Did it pick up the tin can just as it did the iron nails and steel pins? Do you think that a magnet can attract tin?

You can find out by testing a used tube of toothpaste with a magnet. The tube is made of tin. The magnet does not attract the tube. Then how does a magnet pick up a tin can?



Here is an experiment to help you understand why the magnet picked up the tin can. Lay a piece of window glass on some books, as shown in the picture. Put some iron nails on the glass. Then hold a magnet against the glass under the nails. Move the magnet around. What happens to the nails? Does the force of the magnet pass through the glass?

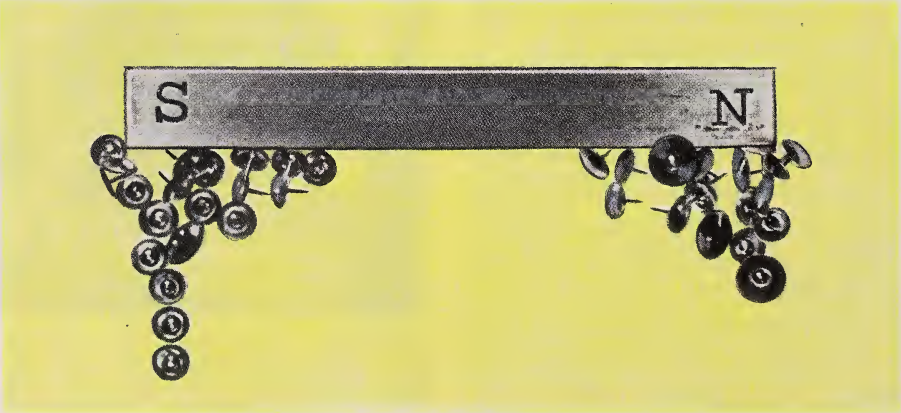
Tin cans and most of the other things we call "tin" are made of thin steel with a coating of tin over them. A magnet will not attract tin, but the force of the magnet goes through the tin and attracts the steel in the can. The force of the magnet will go through the paper label on the outside of the tin can, too. Perhaps you can think of an experiment to show that the force of a magnet will go through paper, cardboard, thin wood, cloth, and other non-magnetic materials.

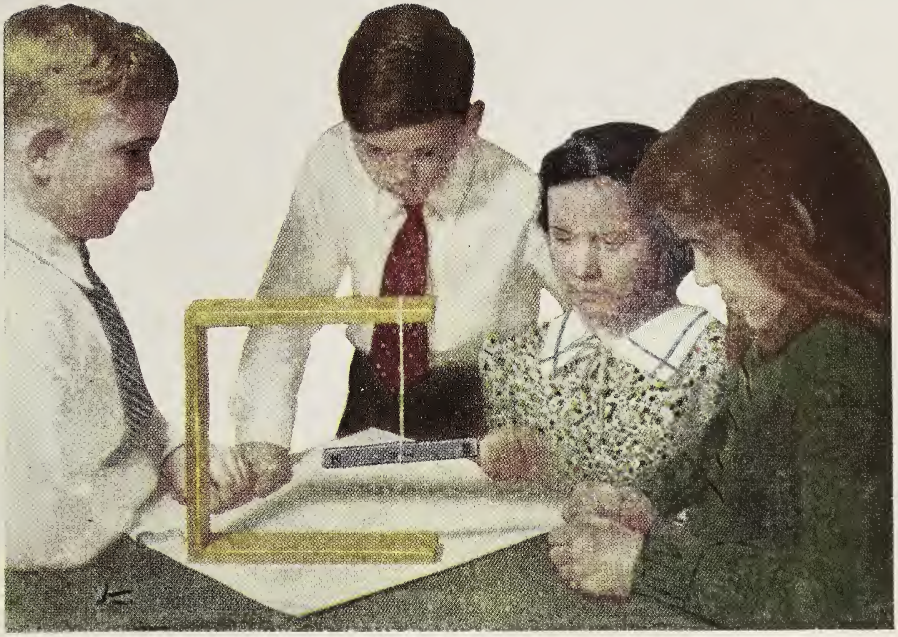
You cannot see this strange force that a magnet has, but you can see what it does and you can feel its pull. You have learned two things about it.

1. A magnet will attract iron and steel.
2. The force of a magnet will pass through many materials.

What are the poles of a magnet?

THERE IS ANOTHER important thing to learn about the force of a magnet. Get some iron tacks and some steel paper clips. How can you tell they are made of iron and steel? Hold a bar magnet in one hand and try to hang the tacks from the magnet. Begin at one end and work along the magnet toward the other end. Which parts of the magnet hold the most tacks? Are there more tacks near the ends or near the center? Where is the force of the magnet strongest? Try the experiment again but use paper clips instead of tacks this time.





Now do another experiment. Spread some iron filings evenly over the bottom of a box. Then lay the bar magnet on the filings and roll it over them. Pick up the magnet. Where do most of the filings stick to the magnet? Try this experiment with a horseshoe magnet and also with a U-magnet.

If you did the experiments carefully, you found that the force of a magnet is strongest near its ends. These ends of a magnet are called its *poles.* One end is called the *north pole,* and the other end is called the *south pole.* As you know, magnets come in different shapes and sizes. But every magnet has a north pole and a south pole. The end marked *N* is the north pole, or *N pole.* The end marked *S* is the south pole, or *S pole.* On some magnets the poles are not marked N and S. On others only the north pole is marked.

Now let us see if we can find out why the poles of a magnet are called north and south. Get a bar magnet whose poles are marked N and S. Tie a piece of string tightly around the middle of the magnet. Then hang the magnet from a wooden stand, as shown in the picture. Why do you

think this stand should not be made of iron or steel?

When you hang the magnet up, be sure that it can swing around easily. Also be sure that there are no other magnets or magnetic materials near. The hanging magnet will swing back and forth for a time and then stop. When it stops swinging, notice in what direction the north pole points. Do you see why it is marked N? Also notice in what direction the south pole points. Do you see why it is marked S? Try the experiment again. Use other magnets, too.

The experiment shows why the poles of a magnet are called north and south. One pole of a magnet points toward the north. It is called the north pole, the N pole, or the north-pointing pole. The other pole of a magnet points toward the south. It is called the south pole, the S pole, or the south-pointing pole.

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1. *Draw pictures of three shapes of magnets. On each magnet put an X in the places where the force is strongest.*
2. *Where are the poles of a magnet?*
3. *Why must you be sure that there are no magnetic materials near the hanging magnet?*

How do magnets act toward each other?

YOU REMEMBER what happened when Billy brought an end of one magnet near the front end of the magnet on his boat. First, the magnet in his hand pulled on the magnet in the boat. And the boat moved toward his hand. Then he turned the magnet in his hand around and brought the other end near the front end of the magnet in the boat. This time the magnet in his hand pushed on the magnet in the boat, and the boat moved away from his hand. Let us see why the boat was first pulled and then pushed.

Here is a way to find out. You can see what happens when one magnet is brought near another. Get two bar magnets with their poles marked N and S. Hang one bar magnet from the wooden stand that you used before. Pick up the other bar magnet and bring its N pole near the N pole of the hanging magnet. What happens? Now bring the S pole of the magnet in your hand near the S pole of the hanging magnet. What happens this time?

You found that when the N poles of two magnets are brought near each other, they push each other away. Or you can say that one N pole pushes another N pole away. You also found that when the S poles of two magnets are brought near each other, they push each other away. You can say that one S pole pushes another S pole away.

Two N poles are of the same kind. So are two S poles. The experiment shows that when two poles of the same kind come close to each other, they push each other away. Two poles of the same kind are called *like* poles. Like poles of magnets push each other away. A scientist says, "Like poles of magnets *repel* each other." Repel means push away.

Perhaps you can guess what will happen when you bring the N pole of a magnet in your hand near the S pole of the hanging magnet. Try it and see. Then hold the S pole of the magnet in your hand near the N pole of the hanging magnet. What happens this time?

You found that the N pole of one magnet and the S pole of the other magnet pull toward each other. These poles are not alike. One is an N pole, and the other is an S pole. We call these *unlike* poles. We say, "Unlike poles *attract* each other."

From the experiments, we can give two rules about how the poles of magnets act toward each other.

1. *Like* poles of magnets *repel* each other.

2. *Unlike* poles of magnets *attract* each other.

Scientists have found that magnets always follow these rules. An N pole always repels another N pole, and an S pole always repels another S pole. Also, an N pole and an S pole always attract each other.

You can show that these rules are true in other ways. Try to pick up one bar magnet with another. First, lay one bar magnet on the other with like poles next to each other. What happens? Then turn one magnet so that unlike poles are touching. What happens this time? Try this again with two horseshoe magnets and with two U-magnets.

Suppose you have a magnet whose poles are not marked. How can you find which is the N pole and which is the S pole? Get a U-magnet that is not marked and a bar magnet that is marked. Touch one end of the U-magnet with the S pole of the bar magnet. If the poles of the two magnets attract each other, what does this tell you about that pole of the U-magnet? If they repel each other, which pole of the U-magnet did the S pole of the bar magnet push away? Then touch the other pole of the U-magnet with the S pole of the bar magnet. Do these poles of the magnets attract each other or repel each other?

If you remember the two rules about how the poles of magnets always act toward each other, you know that unlike poles attract each other and that like poles repel each other. So when you find the pole of the U-magnet that pulls the S pole of the bar magnet, you have found the N pole of the U-magnet. With a piece of chalk, mark a large N on this pole. Then mark the other end of the U-magnet with a large S. Could you now use the U-magnet to find the N and S poles of another magnet?

1. *Write on the board the two rules about how the poles of magnets always act toward each other. Then use two magnets to show that you have written the rules correctly.*
2. *If only one pole of a magnet is marked, can you use it to find the N pole and the S pole of an unmarked magnet? Why?*
3. *The N pole of a magnet attracts both ends of an iron bar. Is the iron bar a magnet? How do you know?*
4. *The S pole of a magnet repels one end of an iron bar but attracts the other end. Is the iron bar a magnet? How do you know?*
5. *What do you think will happen if you bring the N pole of a bar magnet near the middle of another bar magnet? Try it and see.*

Why will a magnet point toward the north and the south?

You know that the N pole of a hanging bar magnet points toward the north. That is why it is called the N pole, or north-pointing pole. You also know that the S pole of a hanging bar magnet points toward the south. That is why it is called the S pole, or south-pointing pole. But do you know why the poles of a magnet always point as they do? Let us see if we can find out.

First, it will be a good idea to make a list of three important things you have learned about magnets.

1. Every magnet has two poles, an N pole and an S pole.
2. Like poles of magnets repel each other.
3. Unlike poles of magnets attract each other.

You can use these three things to help explain why a hanging bar magnet points toward the north and the south. But you must also know one more thing. The earth itself acts like a huge magnet. Maybe that is hard for you to believe, but scientists have found that it is true.

The earth is a huge ball that acts like a magnet. And like all magnets, it has two poles. These are called the earth's *magnetic poles.* One pole is in the far north, and the other pole is in the far south. The one in the far north attracts the north-pointing pole, and the one in the far south attracts the south-pointing pole.

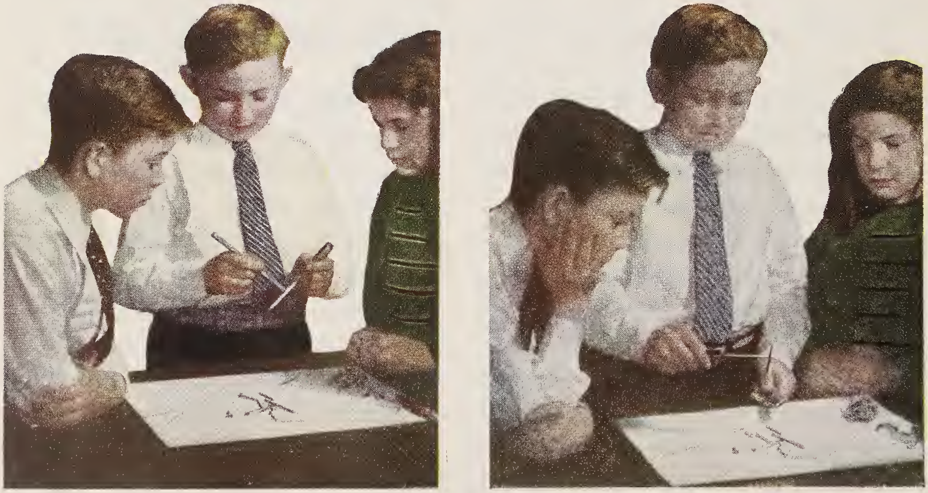
You can probably guess that a great magnet like the earth must be very strong. Its force reaches far out from its poles. Its force is strong enough to pull or push on the poles of a hanging magnet that is thousands of miles away from the earth's magnetic poles.

That is why a hanging magnet will swing back and forth until it points toward the north and the south. When it points in those directions, it stops swinging.

No matter where a hanging magnet is on earth, the magnetic poles of the earth will attract and repel the poles of the magnet.

How can you make a compass?

A *compass* is used to tell direction on the earth. It makes use of what you have learned about magnets. You can easily make a compass yourself, and then you can see how it works. All you need are a marked



Bobby is making his knife into a magnet. How is he doing it? How is he showing that his knife really has become a magnet?

magnet, a steel needle, a flat piece of cork, a knife, and a dish of water. Be sure that the dish is made of glass or china. A compass will not swing around freely in an iron pan. Here are the directions for making a compass. It will look like the picture on this page.

First, make the steel needle into a magnet by rubbing it on one end of the magnet. We call this *magnetizing* the needle. Magnetize means make into a magnet. Rub the needle from the center of a magnet toward one pole. Keep rubbing the needle this one way only—from the center of the magnet to the pole. Do not rub it back and forth.

When the needle is magnetized, test its ends with the S pole of the magnet. The N pole of the needle will be attracted by the S pole of the magnet. Remember which end of the magnetized needle is the N pole.

Now cut a tiny groove across the cork. Lay the needle in the groove. Then float the cork and the needle in the dish of water. Set them in the water carefully so that the cork does not touch the sides of the dish. The cork must be near the center of the dish so that it is free to turn around. Be sure that there are no magnets or magnetic materials near the dish.

If you followed the directions carefully, the cork will turn until the needle points toward the north and the south. It will act just like the hanging bar magnet. The N pole of the needle will point toward the

The first compasses probably looked something like the one you made.

earth's magnetic pole in the north, and the S pole of the needle will point toward the earth's magnetic pole in the south.

No one knows who made the first compass or when it was made. Long, long ago sailors learned to rub an iron needle on a lodestone. This magnetized the needle. Then they floated the needle on a small piece of wood in a pan of water. The wood turned until the magnetized needle pointed toward the north and the south. Then the sailors could use it to tell directions. Lodestone got its name because it was used to make compasses. Lodestone means leading stone.

The compass is one of the most important inventions ever made. You cannot see the North Star in the daytime or on a cloudy night. You cannot see the sun at night or on a cloudy day. But day or night, in clear or cloudy weather, the needle of a compass points toward the north and the south. No wonder ships and airplanes carry compasses!

With a compass, sailors can guide their ships across the ocean when they are far from land. A compass helps an aviator steer an airplane high above the ground or out over the sea. Explorers used compasses to find new lands. A compass showed Christopher Columbus the way across the Atlantic Ocean to the new world of America. Hunters and trappers use compasses as they tramp through thick woods. So do explorers who go on long travels through strange lands. Think of how many safe journeys have been made with the help of a compass!

1. *Why must a compass needle turn easily?*
2. *How can you make a compass?*
3. *What kinds of people use compasses?*
4. *Why is a compass so useful?*
5. *What will happen if a magnet is brought near a compass?*

How can you use a compass?

The compass that sailors, aviators, explorers, and others now use is not so simple as the one you made. But it works in the same way. Look at the compass on page 152. It has a small needle that can turn easily. The needle is a magnet.

Now look at the card under the needle. Do you see the printed letters that stand for the directions? N is for north, E for east, S for south, and W for west. Notice that halfway between N and E are the letters NE. They stand for the direction called northeast. Find southeast. Also find southwest and northwest.

The end of the compass needle that points toward the north is marked in some special way. On small compasses this end is usually colored blue, black, or silver. You can easily tell which end of the needle points toward the north by its color.

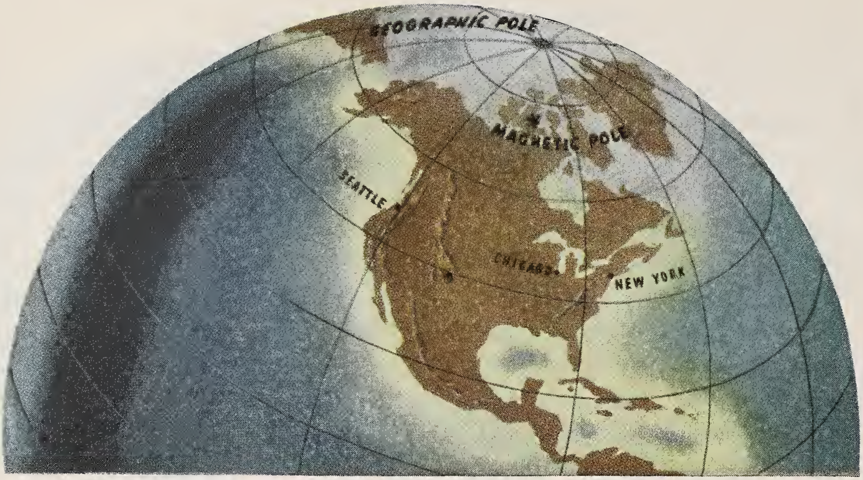
If you have a compass with a colored needle, this is the way to use it. Hold the compass flat in the palm of your hand or set it on a table so that it will be level. When the needle stops swinging, the end of the needle that is colored will point toward the north.

Now turn the case of the compass around so that the letter N is just under the colored end of the needle. This end of the needle points toward the north. The other end will point toward the south. So you can easily find the other directions from the letters on the compass card.

Which way will south be? You know that it is directly opposite to north. When you face north, east is toward your right and west toward your left. South is at your back. Now use your compass to do these things.

1. Walk ten steps east.
2. Point toward the south.
3. Face northwest.
4. Face southwest.
5. Find what direction the front of your school faces.
6. Find the direction of your home from the school.

You learned that the N pole of a compass needle points toward the magnetic pole in the north. Look at the map on page 154 and find where this pole is. Do you see that it is not at the same spot on the earth as the *geographic* North Pole? The geographic North Pole is at one end of the earth's axis. The magnetic pole in the north is over a thousand miles south of the geographic North Pole! And the magnetic pole in the south is over a thousand miles north of the geographic South Pole! Of course, the compass needle points



toward the magnetic poles. You can see why at most places on the earth the compass does not point exactly to the geographic North Pole. But it points so close to north that we can use it to find directions.

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1. *Write down the most important things you have learned about a compass.*
2. *Where would the magnetic poles have to be to make compass needles point exactly north and south everywhere on earth?*

QUESTIONS TO ANSWER

1. How could a magnetic tack hammer keep you from hitting your fingers if you were driving tacks?

2. A story was once told of a thief who stole silver and gold coins from people's pockets with a magnet. Do you believe the story? Why?

3. Find out whether a compass points exactly north in your locality or whether it points east or west of north. Explain why knowing this would help you find directions with a compass.

4. Bud and Jimmy were doing a science experiment. They were trying to find out if a magnet would pick up pins. Bud tried four pins that were lying on the science table. The magnet picked all of them up. Bud said, "Magnets will always pick up pins."

Jimmy found some other pins and tried to pick them up with a magnet.

He discovered that the magnet would not pick up some of these pins. Jimmy said, "Magnets will not pick up all pins. They will pick up only those that are made of iron or steel."

Which of the boys was the better thinker? Why do you think so?

If the two boys were telling you things they had found out about magnets, which boy would you believe?

THINGS TO DO

1. Find out if these things are true by doing some experiments with magnets.

   a) Some magnets are stronger than others.
   b) A magnet's force will pass through a piece of leather.
   c) A nail is itself a magnet when it is touching a magnet.
   d) A magnet can be used to pick iron filings out of sand.

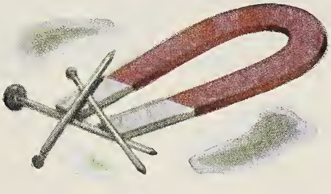
2. Find out whether the force of a magnet will pass through iron and steel.

3. Try to use a compass to find out which of two magnets is stronger.

4. Make a magnetic theater. Use a cardboard box for the toy stage. Cut figures of the actors out of cardboard and fasten paper clips or tacks to their feet. Move the actors by moving a magnet under the stage.

5. Make a magnetic fish pond. Cut out little paper fish and fasten a paper clip to each. Put these in a box. Tie a magnet to a pole and then see who can catch the most fish.

6. Find out what an electromagnet is and how it works.



★ *In Unit Seven You Will Learn* ★

★ What you can do to keep your body well ★
★ How food helps you ★ Why you need exercise and rest ★
★ How the right clothes help keep you healthy ★
★ How you can keep from catching diseases ★
★ How you can keep from having accidents ★

★ UNIT 7 ★

How Can You Keep Well?

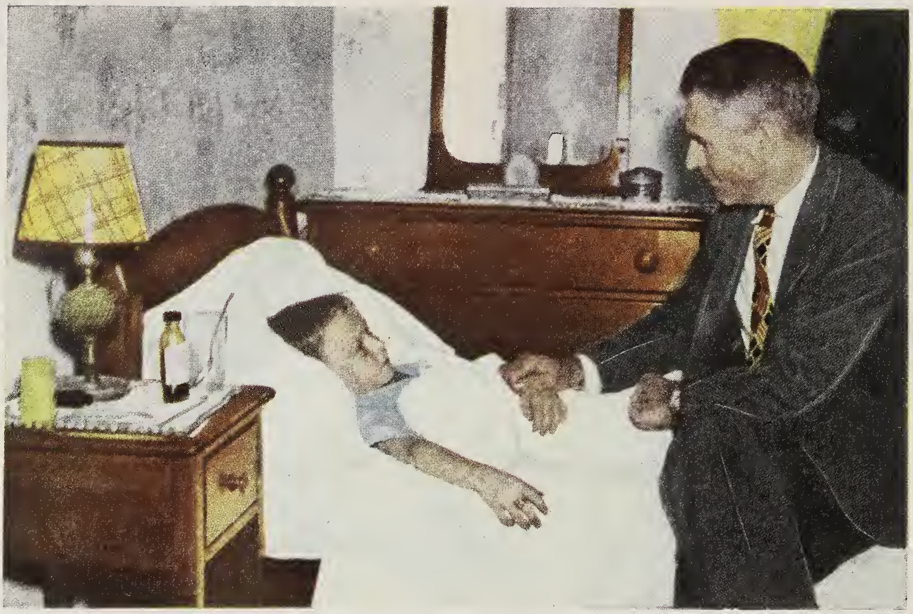
"IT'S RUNNING so smoothly you can hardly hear the engine going," said Jack to his father as their automobile moved down the street.

"I just had it tuned up," said Jack's father. "The man at the garage changed the oil and greased everything thoroughly. He tightened some of the parts and put air in the tires. He says the car's in apple-pie order."

When all of the parts of an automobile are doing their work properly, the car runs along smoothly. But when a tire blows out–*Bang*–there is trouble. Or if there is water in the gasoline–*Chug*–the car stops. Or if some part breaks or does not work as it should–*Knock*–the driver begins to wonder what the trouble is and where the nearest garage or filling station is.

Your body is somewhat like an automobile. You know that all of the parts of your body work together so that you can do many different things. Before you read this unit, think how a well body is like a smooth-running automobile and how a sick body is like a broken-down automobile.

When you are well, you seldom think about your body. It runs along without much attention from you. You wake up in the morning, and you feel rested. Your mother says, "Good morning, how are you feeling?" And you say, "I feel fine. What are we having for breakfast?" You are full of pep, and you are hungry. You eat your breakfast and are off to school. You work, play, and enjoy yourself. Your body is running as smoothly as a new automobile.



How do you feel when you are sick?

But sometimes things are different. You have a headache. You feel chilly even when everyone else feels warm enough. Or you feel so hot that you think you are roasting when everyone else feels comfortable. You sneeze and you cough. Your mother says, "I'm afraid you are coming down with a cold. You had better stay home today."

Or perhaps you have a headache and a sore throat. You look so sick that your mother says, "I think we should ask the doctor to stop in and take a look at you." So the doctor comes. He says to you, "Tell me how you feel." And you say, "I feel terrible." Then he wants you to tell him where you feel bad or what part of you hurts or anything else about you that feels queer.

After you tell him how you feel, he may say, "Well, I think I'd better take your temperature." He puts his thermometer under your tongue, and you cannot talk for a few minutes. While he is waiting for the thermometer to tell your temperature, he puts his fingers on your wrist and counts your heartbeats!

There is a blood vessel in your wrist. Every time your heart beats, it pushes your blood through this blood vessel and makes a beat. So the doctor can tell how your heart is behaving by counting these beats. He can tell whether it is beating too fast or too slow. At your age it should beat about ninety times a minute. As you grow older, your heart will beat fewer times a minute.

After a few minutes the doctor takes his thermometer out of your mouth and reads it. It should read about 98.6 degrees. If it reads much higher than this, he is sure that you have a *fever*. He knows that something is surely the matter with you. Then he may say, "Let me look at your chest." He takes a look. Probably he calls your mother and says, "Look at this." She looks and sees that there are several tiny red spots. Then the doctor says, "This child has measles!" So you go to bed for a few days until you feel better.

The fever, the headache, the sore throat, and the red spots are signs that help the doctor find out what is the matter with you. Signs like these are called *symptoms*. When you tell the doctor your symptoms, you are helping him find out what is wrong with you. The sooner the doctor learns your symptoms, the sooner he can help you get well.

Tommy is having his eyes tested at school. Then his teacher will tell his parents if he needs to go to an eye doctor.

That is why it is wise to call a doctor when you feel sick. Sometimes people wait too long before they call a doctor. Then he may have a very hard time helping them get well. Wise people have learned that it pays to ask advice of a doctor before they get very sick.

Many schools have doctors and nurses to examine girls and boys and help them when they are sick. These doctors and nurses are anxious to help you get well, and they are also anxious to keep you from getting sick. It is much easier to do things that will keep you from getting sick than it is to cure you after you are sick.

Your school nurse and doctor and your family doctor will be glad to know that you are learning how to keep well. Talk to them about what you learn or ask them to help your class by talking to you about keeping well.

1. *Why should you call a doctor if you are sick?*
2. *Why do you think you should tell your doctor where you have pain or how you feel queer if you are sick?*
3. *What does* symptom *mean? What symptoms do you have when you have a cold?*
4. *Suppose you were sick and had several symptoms. Would you take a medicine just because an advertisement said it would cure these symptoms?*
5. *Why do you think that people should see a doctor once each year even if they are not sick?*

How can you help keep your body well?

NO GIRL OR BOY or man or woman likes to be ill. Sometimes when you get sick, there is nothing you could have done to keep well. But very often if you had taken better care of yourself, you would not have been sick at all. Your body needs good care even more than an automobile does. You cannot buy a new body every few years. You know, of course, that some automobiles run for years and years without any breakdowns at all. Usually this is because the owners take good care of them. Girls and boys can learn how to take care of their bodies in the same way. Let us see how.

You have already learned how important your heart is to your body. It pumps the blood that carries food to all parts of your body. The blood carries oxygen to all of the parts, too. Without a good heart, you are about as well off as an automobile without a good pump to feed gasoline into the engine.

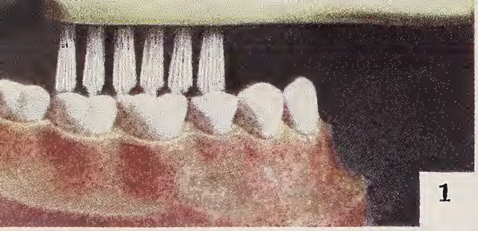
Be careful not to overwork your heart. Whenever you exercise, your heart beats faster and pumps the blood faster. That is a very good thing if you are careful not to exercise too hard or too long. Here is a picture of a girl skipping rope. She is having fun, and her heart is very busy keeping the blood moving inside her. *If* she stops when she gets tired, then the exercise will be good for her. *If* she keeps exercising too long and gets too tired, the exercise may be bad for her. She may overwork her heart.

Sometimes after you have been sick, your heart is not so strong as it was before. After an illness your doctor may say to you, "Take it easy for a while. Don't exercise too much."

You remember that your lungs are another important part of your body. The air that you need gets into your body through your lungs. You need to breathe deeply so that air gets down into every one of those little pockets in your lungs.

Having good *posture* is an important way to help your lungs. Having good posture means holding your body correctly. One part of good posture is sitting up straight or standing up straight. When you are sitting or standing straight, you can breathe deeply. When you are all hunched over, your ribs are crowded together. They cannot move out to make room for your lungs to swell with air.

You remember that your teeth chop and grind your food so that your body can use it. Have you done anything today to help your teeth so that they can do their work? You should brush them each morning and evening to keep them clean.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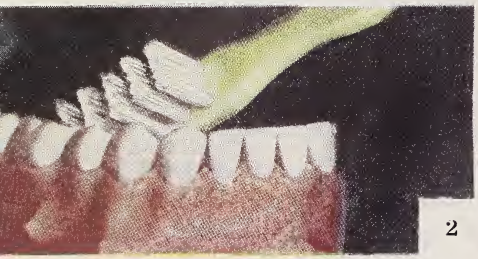
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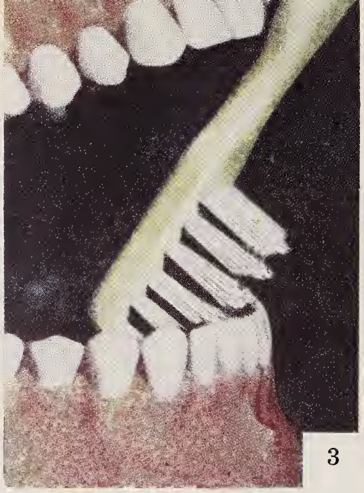
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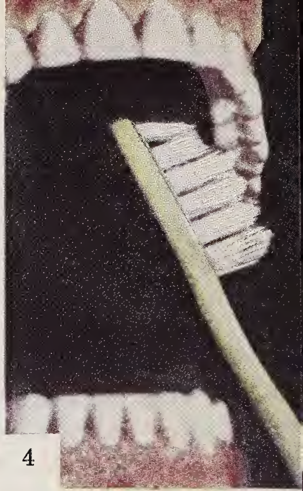
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And brushing them correctly is very important, too. The pictures on this page will help show you how. Picture 1 shows you how to hold your brush when you brush your large chewing teeth. Always brush the tops of your chewing teeth first. Then brush the outsides of your teeth. Always move the brush straight up and down when you brush the outsides. Brush the inner sides of your teeth last. Pictures 2, 3, and 4 show you how to hold your brush when you brush the insides of your teeth. Always let your brush get dry before you use it again.

You should have your dentist look at your teeth at least twice each year, or as often as your dentist thinks he should. If they need repairing, he can fix them before they are so badly decayed that they have to be pulled.

Foods that are good for growth and health are also good for your teeth. Milk is one of these foods. Drink plenty of it. Fresh fruits and fresh vegetables help, too. Eat plenty of them. Good, strong teeth will help you keep well.

Your ears must be taken care of, too. Perhaps you think that they are troublesome, because your mother is always telling you to be sure to wash them. A doctor once said, "The only things that should ever go into your ears are a washcloth and your elbow!" Of course, he was partly joking. You cannot reach your ear with your elbow. He meant that you should always keep your ears clean. But he also meant that you should never try to clean them by putting any sharp-pointed things in them.

Keeping your ears clean will help keep them well. But putting anything sharp in them may harm them very much. It may break or pierce the *eardrum.* This eardrum makes it possible for you to hear. The eardrum is a very thin part that is easily broken.

Even a very loud sound may harm it. So you should never shout directly into anyone's ear. Hitting someone on the ear may break this thin eardrum, too. If the eardrum is broken, you may not be able to hear at all. Find the eardrum in the picture on page 84.

Blowing your nose too hard when you have a cold may harm your ears, too! When you have a cold, there are many germs inside your head. If they get inside your ears, they may cause you serious trouble.

Look again at the picture on page 84. You will see that there is an opening between the nose and the ears. If you hold your nose and then try to blow it, air presses back through this opening into your ears. Germs from your nose are blown back into your ears and may cause trouble there.

This girl is reading with a good light.

Your eyes need care, too. Here is a list of important things that you should remember to do or not to do in caring for your eyes. Read the list and try to follow these rules every day.

Safety rules for taking care of your eyes

1. Have a doctor examine your eyes to see if you need glasses.
2. If you wear glasses, be very careful not to break them when you have them on. Be careful not to do anything that might break someone else's glasses.
3. Do not use another person's towel to wipe your face and eyes. It may have germs on it that will get into your eyes.
4. Do not rub your eyes with your fingers. You may rub dirt into them.
5. Do not look straight at the sun.
6. Do not read in light that is very bright and glaring. Light from the sun or from a lamp should not shine directly into your eyes.
7. Do not read in a light that is so dim that you cannot see clearly.

You need to take care of your skin, too. Two things are important to remember about your skin.

1. Keep it clean.
2. Be careful to keep it from getting cut or burned.

A bath with warm water and soap cleans your skin and washes off perspiration. Dust and dirt that fill the pores in your skin are washed away, too. You should take a warm bath or shower at least twice every week. Use plenty of soap. If you want to keep your skin clean and healthy, you must wash it often.

Much of the perspiration soaks into the clothes next to your skin. So the clothes that you wear next to your skin should be changed often and washed in hot, soapy water.

Wash and brush your hair, too, so that it will be clean and so that the skin on your head will be clean. Keep your comb and hairbrush clean, too.

The skin covering of your body keeps germs from getting inside you. The skin does this if you do not cut it or tear it. When your skin is opened at any place on your body, the opening is a door for germs to get in. That is why it is so important for you to keep from cutting your skin or in any way breaking it open.

If you do cut or burn yourself, you should take care of your wound at once even though it is only a scratch. A small cut that has stopped bleeding can be washed and covered with a clean bandage. But if the wound is a bad one, keep it clean by covering it with a bandage that will keep out the dirt until you can see a doctor or a nurse. A doctor or a nurse knows how to take care of a wound to make it heal as quickly as possible.

You have learned that you should take good care of your heart, lungs, teeth, ears, and eyes. And you know that it is important to bathe and change your clothes. You have also learned that germs must be kept from getting into your body through cuts or breaks in your skin. These things and others that you will learn as you study this unit can help you to keep your body well. But there are some other things you can do, too. Do you know what they are?

Just because you know about things that can make you sick, you should not worry about them. Instead, use what you learn to start good habits of keeping well. Try to be happy and cheerful. This is very important at mealtime. If you are cross or angry, the food you eat will not digest well.

You know that your brain is the director of your body. It tells the other parts of the body what to do. But your brain cannot do its work well if you are worried or afraid. Neither can your heart, your stomach, or your intestines. If you are worried or afraid about something, talk to a grown-up about whatever is bothering you. Your mother, father, or teacher can help you get over your worries or fears.

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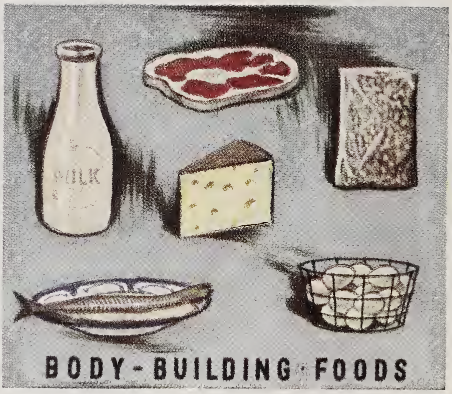
1. *Make a set of rules that will help you keep from getting sick. Learn the rules and follow them.*
2. *Why is it important for each of these parts of your body to be well?*
   Heart Lungs Ears Eyes Teeth Skin
3. *Why should you be careful about blowing your nose hard if you have a cold?*
4. *How can you tell if your ears, eyes, or teeth need special attention of any kind?*
5. *Why may even a small burn or a tiny cut in your skin be dangerous?*

ENERGY FOODS



BODY-BUILDING FOODS

How does food help you keep well?

TWO VERY IMPORTANT things to remember about keeping your body well are these.

1. Your body needs food.
2. It needs the right kinds of food.

You cannot expect to keep healthy and feel well if you do not eat plenty of good food.

Your body uses the food you eat for several different things. Some of the food gives you pep and energy to play and work. Some helps you grow. Some helps you keep from getting sick. Some helps make blood and the other liquids in your body. Do you see why you should eat many different kinds of foods?

The foods that give you pep and energy are sometimes called *fuel foods* or *energy-giving foods.* When we say that a person has plenty of energy, we mean that he can get lots of work done in a hurry. Scientists say that energy is the ability to do work. Bread, cereals, potatoes, sugar, and butter are some of the kinds of fuel foods or energy-giving foods. When you eat these foods, your body uses them for fuel very much as an automobile uses gasoline. You need some of these fuel foods for breakfast, for lunch, and for dinner.

Some of the foods that help build a strong body are meat, fish, eggs, and milk. Milk is very good for you because your body uses the materials in milk for building bones and teeth. Every meal that you eat should have some of the *body-building foods* in it.

You have probably heard your parents talk about *vitamins.* These vitamins help protect your body from certain diseases. Foods that contain vitamins are called *protective foods.*

There are several different kinds of vitamins. Each kind does a different thing for your body. Some foods contain one kind of vitamin. Some contain other kinds. Later on, you will learn more about these vitamins and how they protect your body.

Here are some of the kinds of foods that contain the vitamins you need: green, leafy vegetables, such as lettuce and cabbage; other vegetables, such as celery and tomatoes; fruits, such as oranges, grapefruit, and lemons. Whole-wheat bread and milk also contain vitamins. If you eat plenty of these foods, you will probably get enough vitamins.

Sometimes your doctor may think that you need more vitamins than you are getting in the food you eat. So he will have you take vitamin pills. Some pills give you one kind of vitamin, and some give you another kind. The doctor will know which kind you need and how many pills you need to take each day.

The water your body needs to make blood and the other liquids comes from the water and the milk you drink. Some of it comes from fruits and vegetables and their juices, too.

When you eat at home, your mother probably plans your meals so that you will get plenty of the right kinds of foods. When you eat in the school cafeteria or are on a vacation trip, you may choose your own food. Then you should use what you have learned to help you. On page 168 is a picture of the food a boy chose for himself for breakfast. Here are the things he selected: orange juice, oatmeal, milk, toast, and an egg. Do you think he made a good choice? Why? How will these foods help keep him well?

On page 168 is also a picture of a girl choosing her lunch at a school cafeteria. She is going to eat scram-

bled eggs, lettuce and tomato salad, a whole-wheat roll, a baked apple, and an oatmeal cookie. She has milk to drink. Is she making a good choice of foods? How do you know?

Some kinds of foods do not help your body in any way. They may even take away your appetite for the foods you need. Coffee and tea are not good for growing children. They do not help you grow. They do not protect you from disease. They do not give you energy.

Candy gives you energy. But it may be harmful for you, too. Do you know why? If you eat candy between meals, you will probably not be hungry at mealtime. The best time to eat candy is soon after you have eaten lunch or dinner.

Eating between meals is usually not a good idea, because it spoils your appetite for your meals. But if you are hungry after school, a glass of milk and a cookie are the best things to eat.

1. *Explain why you should eat several different kinds of foods at each meal.*
2. *Why should you drink plenty of milk?*
3. *Do you think it is a good idea to take vitamin pills without asking a doctor if you need them? Why?*
4. *If you went to a cafeteria, how could you choose the right kind of foods?*
5. *Decide what kinds of foods would make a good dinner. List these foods and tell why you chose them.*
6. *Why may eating between meals be bad for you?*

Why do you need exercise and rest?

EXERCISE AND REST both help keep you well. Here are important things every boy and girl needs to remember about exercise. Which ones do you already know? Which ones are new to you? Most important of all, *Which of these rules do you follow?*

1. Do not exercise too hard at first. "Warm up" slowly.
2. Do not exercise too long or too hard. Do not play until you are "dead tired."
3. Do not exercise right after breakfast or lunch or supper.
4. Cool off slowly after you have been playing hard. Do not sit in a draft to cool off fast.

Exercise makes your muscles strong. A boy or girl who skates, swims, plays games, hikes, and takes other kinds of exercise will have stronger muscles than one who does not. Exercise makes you breathe deeply. Breathing deeply gets more air into your lungs and gets this air into all parts of your lungs, too. This helps you keep well.

Rest is just as important for you as exercise. After you have worked and played all day, your body is tired. Some parts of your body get worn out when you exercise. Your body needs time to repair the parts that have been worn out. Boys and girls of your age need lots of sleep. Look

at the chart below and find out how much sleep you should have every night.

Years Old	*Hours of Sleep*
6-7	12
8-10	11
11-13	10-11

Here are the important things to remember about rest and sleep.

1. Be sure to get enough rest and sleep.
2. Go to bed regularly in time to get the right number of hours of sleep for your age.
3. Sleep in a dark room with the windows partly open to give you plenty of fresh air.

If you use the rules on these pages when you exercise and rest, you are much more likely to keep well than you are if you do not make it a habit to follow them.

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1. *List the rules that you should follow when you exercise and rest. Try to follow them carefully.*
2. *Why do you need exercise and rest?*

How can the right clothes help you keep healthy?

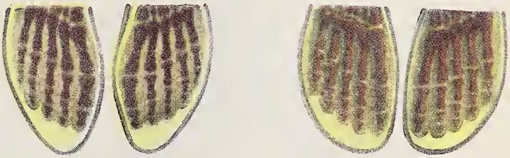
EVEN THE CLOTHES you wear can help you keep well. Do you know how your clothes can do this? We often say, "That is a very warm coat." But if you feel the coat, it does not feel warm. The coat itself is not warm. Yet it can keep you warm. It keeps you warm by holding in the heat of your body. If you feel your body, you can feel the warmth in it. The coat and other clothes you wear keep this warmth from getting away. So your body is kept warm.

In winter, you need clothes that will keep the heat from getting away from your body. In summer, you need clothes that will let the heat get away. That is why you have some clothes for winter and other clothes for summer. When you are indoors, you do not need so many clothes as you do when you are outdoors. That is why you should take off your heaviest clothes when you come indoors and put them on again when you go out into the cold. Do not sit around indoors with your outdoor clothes on.

It is fun to walk and play in the rain and snow. But it is better for your health if you are dressed for it. Rubbers, raincoats, and overshoes keep you dry. If you go outside in the rain and snow without the right clothes, your clothes soon are wet through.

You feel chilled because the heat from your body gets away easily through wet clothes. When you are chilled, you may easily take cold. Whenever you come in from outdoors and your clothes are wet, you should put dry clothes on at once.

You should wear shoes that fit your feet correctly. Here is a picture of a girl buying a pair of new shoes. She is looking into an X-ray machine to see how her feet look inside the shoes. The machine shows her whether the shoes are too long or too short or whether they are too wide or too narrow.



The small pictures show how her feet might look in her shoes. They will look like the feet on the left side if the shoes are too narrow. They will look like the feet on the right side if the shoes fit correctly. Can you tell how the feet are different?

If you keep on wearing shoes that are too small, your toes may get squeezed out of shape. Tight shoes often cause blisters and other sores on your feet. They are often dangerous as well as very uncomfortable. Shoes that are too large may rub up and down and make blisters, too. The next time you get new shoes, be sure that they fit you well.

1. *Explain how your coat keeps you warm.*
2. *What kinds of clothes should you wear for different kinds of weather? Explain why you should wear those kinds of clothes.*
3. *Are you wearing the right kind of clothes today? Explain your answer.*

Farmers who sell milk should keep their cow barns as clean as this one.

How can you keep from catching diseases?

GERMS ARE ENEMIES of a well body. In Unit Three you learned that germs are very tiny plants or animals that can make you sick when they get inside your body and grow there. Some kinds of germs cause one disease. Some kinds cause another. Germs can make you sick only if they get inside your body. You have already learned one way in which germs get inside you. They go in through cuts and breaks in your skin. Germs get into your body in other ways, too. Do you know some of these ways?

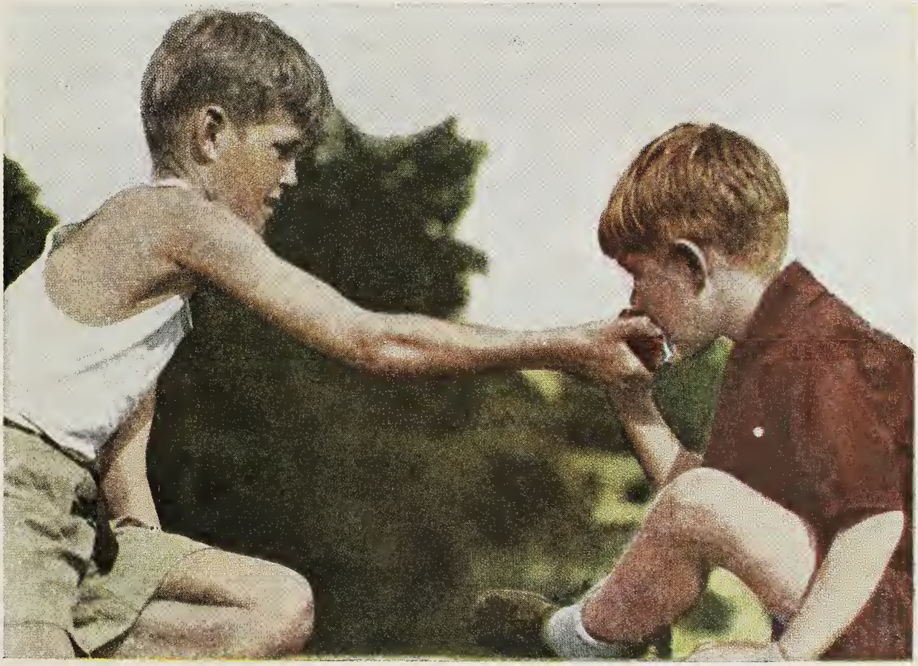
Germs can get into your body on the food you eat and in the water you drink. You put them in your mouth if you put your dirty fingers in your mouth. They can get in through your nose when you breathe. Germs are spread from people who are sick to people who are well. Can you think of some of the ways you can keep germs from getting into your body?

All food and water that you eat and drink should be clean. Fruits and vegetables should be carefully washed before they are used. Food should be kept covered so that flies will not walk on it. Be sure to buy your food from stores that keep the food clean.

You know that milk is one of the most important foods you need. It is good food for germs, too. That is why you should be sure to drink only clean milk. The people who handle the milk should also be clean. The cows that give the milk should be kept clean, too.

Just to be very sure that there are no disease germs in the milk you drink, look on the label of the bottle and see if the milk is *pasteurized.* This means that the milk has been heated enough to kill the germs that may be in the milk. It is always safest to drink milk that has been pasteurized.

The germs that cause several serious diseases are carried in water. If you live in the city, your drinking water is probably made safe by the city. If you live in the country, your well water should be tested by the Department of Health every now and then to make sure that it is safe for you to drink.



Sometimes it is better not to share things. Can you tell why this is true?

When you are on a picnic or a camping trip, do not drink water from streams or springs unless they have a sign saying "Safe Drinking Water." It is best to boil water unless you are sure that it is pure. Always use your own cup or glass and do not drink out of cups left in public places. At school be careful not to touch the drinking fountains with your mouth.

Some people have a bad habit of putting their fingers in their mouths. Just think of the number of things your fingers have touched in the last few hours. All of these things may have germs on them. Whenever you bite your fingernails or put your fingers in your mouth, you are helping these germs get into your body. Do not put your fingers into your mouth. Then you will not help germs get inside of you.

There are many more things to learn about how to keep germs from getting inside of your body to make you sick. There are also many things to learn about how you can help keep disease germs from spreading. There is one important thing you can do. If you have a cold, stay away from school until you are well. Coughing and sneezing spread colds very quickly. If you must cough or sneeze, be sure to cover your nose and mouth with your handkerchief.

Later on, you will learn more about what germs are and how they travel from one place to another. You will also learn what they do inside your body and how your body fights them.

1. *Make a list of the ways that germs can get into your body. Then explain what you can do to keep them out.*
2. *How can you be sure that the milk and water you drink are pure? Why do they need to be pure?*
3. *Why should you keep your fingers out of your mouth?*
4. *Tell what things you have learned about each of these.*

Germs *Coughing* *Pasteurizing*

How can you keep from having accidents?

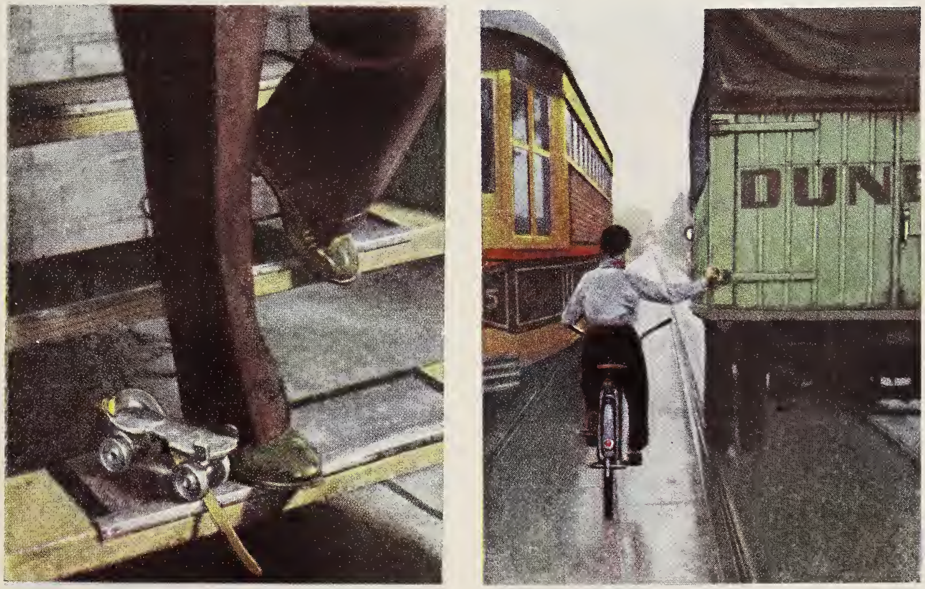
EVERY YEAR hundreds and hundreds of boys and girls are hurt at home, on the streets, or at school, where they work and play. That is why you should learn how to play and work so carefully that you will not have an accident. If you read these pages and study the pictures and then remember to do what you have learned, you may be able to keep yourself or someone else from getting hurt.

One picture shows a roller skate that has been left on a stair step. In a few minutes someone may hurry down the stairs and step on the skate. This person may fall and be very badly hurt. Never leave toys or other things in places where someone may fall over them. Never leave your bicycle or wagon in any place where someone may fall over it after dark. Of course, you know that you should not do these things. But do you *remember* not to do them?

Scissors, knives, and other sharp things often cause very bad accidents. Running with scissors in your hand is very dangerous. If you fall, you may get hurt. When you are cutting with a knife, cut *away* from your hand, never *toward* your hand.

Almost every day children are burned because they light matches and set fire to their clothes. Here is a safe rule for you to follow. *Never light a match unless an older person is with you.* Always be very careful with matches.

Bonfires are lots of fun to watch. But they are often very dangerous, too. They can blaze up and set peo-



Is the boy using his bicycle safely? What accidents might happen?

ple's clothes on fire. Boys and girls should never build bonfires unless some grown-up person is with them. If your clothes ever should catch fire, *do not run.* Running will only make the fire burn faster. Cover yourself with a blanket or coat. Or lie down and roll over slowly on the ground.

Drinking anything from a bottle that you find in a medicine cabinet or a cupboard is a dangerous thing to do. Some of the bottles may have poison in them. They may not have labels on them. Never put anything from the medicine cabinet in your mouth unless you know what it is. Then you will be sure never to make a mistake.

You will need to be careful many times when you are on the way to school. If you live in the country and walk to school along a highway, walk on the left side of the road. Then you can always see an automobile that is coming toward you and can get off the road. A car coming behind you will be on the other side of the road.

In a town or city where you have to cross busy streets, stop and look both ways before crossing. If your school has a Safety Patrol, cross only where the Safety Patrol is helping children across the street. Always obey the Safety Patrol as the boys and girls in the picture are doing. Take time to be safe. Get up early enough so that you do not have to run to school. It is very easy to forget to look both ways when you cross a street if you are in a hurry.

Do you have roller skates or a bicycle? Be sure that you always use them safely. Think of other people on the sidewalk when you are skating so that you do not run into them. Skating in the street is never safe.

Many accidents are caused by bicycles. If you ride in the street, always keep to the right side near the curb. It is never safe to hang on to the back of a truck while you are riding. Riding on the sidewalk is dangerous for people walking there. Always have a bell so that you can warn people quickly. It is safest not to ride a bicycle at night. But if you have to ride at night, be sure to have a light that is in good working order on the front of your bicycle. On the back, have a tail light or a reflector.

You can remember the safety rules for riding bicycles if you make a list of the important things you read on these pages. Then be sure to remember to do the things that will keep you and other people safe.

There are many, many accidents at school because people are not careful. Do not hurry or crowd on the stairs. You may fall and break an arm or a leg, or you may cause someone else to fall. When there is a fire drill, obey the rules quickly but quietly. Then you and your classmates will get into the habit of leaving the building in an orderly way. If there is a real fire, no one will be hurt because of someone else's carelessness.

When people are drinking at the drinking fountain, do not shove or push anyone's face down against the fountain. You may hurt his teeth or eyes very badly if you do.

Outdoors on the playground there are many things you can do to keep from being hurt. Some schools have a clean-up committee to see that there are no nails or pieces of broken glass or metal that could cut or injure the children. You may find that this is a good idea. Do not ride bicycles on the playground. You may run into

someone and hurt him very badly. When you play on swings, slides, and other playthings, be sure not to hit anyone.

After school, on holidays, and during your vacation, you will be doing many different things. You will have much more fun if you do them safely so that you do not have a serious accident. Of course, it is no fun to spend a lot of your vacation in bed. It is no fun to be unable to do things you had planned just because you were careless. Remember the safety rules that you have learned about using skates and bicycles.

In wintertime, when you want to go coasting, find a safe place to do it. In many towns the police will help you by roping off a hill for coasting. Find out if there is such a hill near you and go coasting there. Always coast on a hill that is safe from passing cars. Coasting down a hill or driveway that leads to a busy street is a very dangerous thing to do.

Ice skating is fun and good exercise, but be careful on deep ponds. It is safer to skate on a pond that has been made by flooding a shallow place. But if you go to a real pond or a river to skate, be sure that the ice is safe. If there is a hole or spot marked "Danger! Thin Ice!" stay away from it. Being safe is always wiser than trying to be daring.

In the summer, swimming is one of the most healthful sports. But there are some rules that you should remember to follow. Always wait at least two hours after eating before going into the water. You may get cramps if you swim soon after you have eaten. Do not go swimming alone. Go with someone else. Go with an older person who knows how to swim if you are not a good swimmer. Of course, you must be sure to stay in shallow water until you can swim well or unless you have a good swimmer with you. If you can swim well, you will have a great deal of fun. And still more important, being able to swim may save your life sometime.

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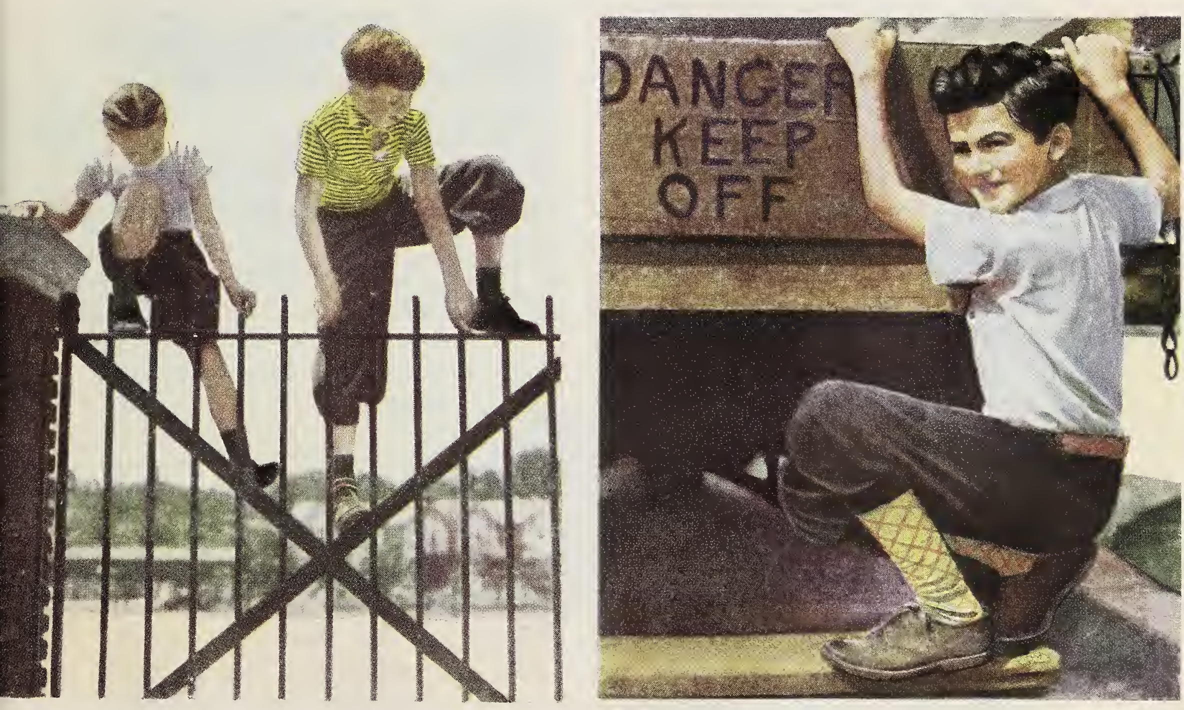
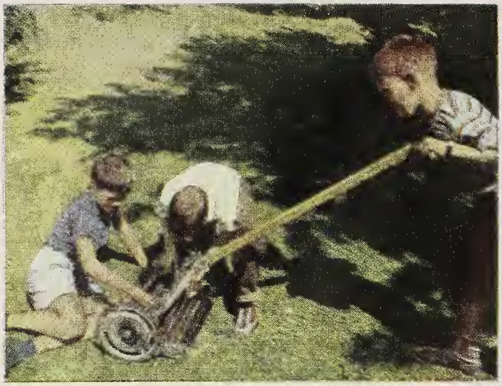
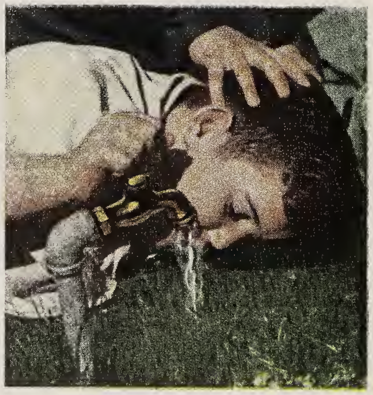
1. *Look at the pictures on pages 175-179. Which ones show you ways to act safely? What accidents can be prevented in these ways?*
2. *What rules for safety should you follow when you do each of these things?*

   Swim Walk to school Skate Ride a bicycle
   Play on the playground Go coasting
3. *Make a list of rules that tell you how to keep from having accidents at home. Then remember to follow these rules.*



Do you think these boys might have accidents? What do you think might happen?





QUESTIONS TO ANSWER

1. Look at the pictures on these two pages. What accidents could happen to these boys? What safety rules can you think of for each picture?

2. Why should you each have your own comb, brush, toothbrush, towels, and washcloths? How should you take care of these things?

3. Make a list of the foods you eat at your meals during a week. Are you eating some of the right kinds of foods at each meal? If not, tell what you could do to make your meals more healthful.

4. Make a list of five things which you should not do because they are harmful to your body. In what way does each of these things harm your body?

5. Think of some accidents that you have seen or heard about. Answer these questions about the accident.
   - *a*) In what way did the accident happen?
   - *b*) Whose fault was it?
   - *c*) How could it have been prevented?

THINGS TO DO

1. Tell why you think boys and girls should learn about the things that are in this unit.

2. Make a list of everything you can do at home and at school to help keep things clean. Put the list on a large chart to help you remember to do these things.

3. Find out more about good posture. Then do the things that will make your own posture better.

4. Find pictures in magazines and newspapers that show people using their eyes incorrectly. Find pictures that show people using their eyes correctly.

5. Ask your doctor or school nurse to talk to you about how to keep well and how to avoid accidents.

6. Talk with your mother about how she plans your meals so that you will have the correct food.

7. Find pictures of different kinds of foods in magazines and newspapers. Cut the pictures out, paste them on a chart, and then tell what each food does for you.

8. Find out more about how foods are kept fresh and clean at the store and at home. Look for pictures that show some of the ways.

9. Find pictures that show places where accidents may happen. Tell what you could do to keep from having an accident.

10. If you do not already have a Safety Patrol in your school, find out how you can organize one.

★ *In Unit Eight You Will Learn* ★

★ *What happens when animals grow* ★ *How insects grow* ★
★ *How amphibians grow* ★ *How other groups of animals grow* ★
★ *How plants with seeds begin to grow* ★ *How plants grow taller* ★
★ *How the roots of plants grow longer* ★ *How the stems get thicker* ★
★ *In what directions the parts of plants grow* ★

★ UNIT 8 ★

How Do Animals and Plants Grow?

Do you remember the snowman you talked about in the first unit of this book? You remember that you compared a snowman with a real man and decided that a snowman is not a living thing. One of the reasons you gave for deciding that way was that a snowman cannot grow.

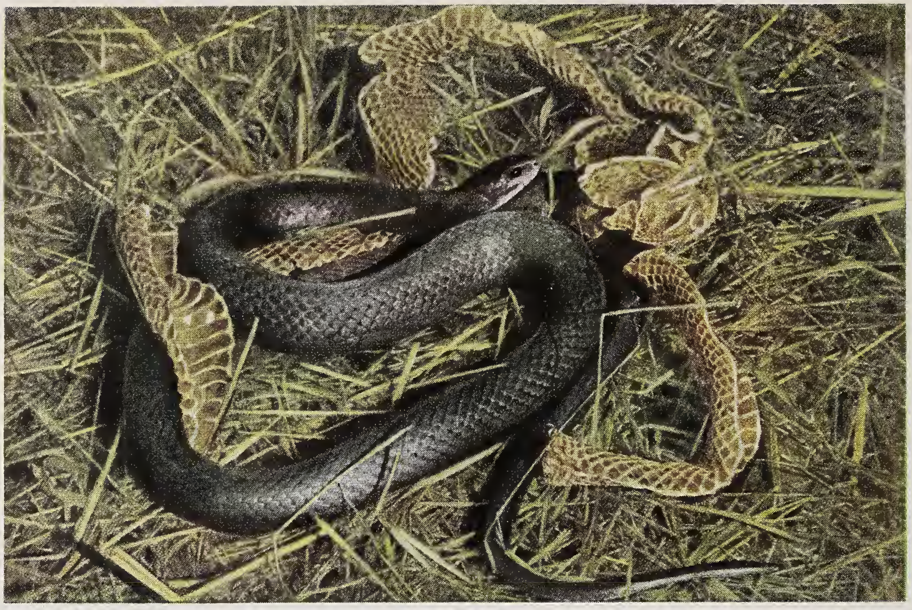
But if you ever made a snowman, you know that you begin by making a little ball of snow in your hands. Then you start rolling it. As you roll the ball, it keeps adding more snow and getting bigger and bigger. This looks as if the snowball is growing.

You know that animals and plants do not get bigger in this way. The snowball gets bigger by just adding more snow on the outside. But a kitten or a dog does not get bigger by just adding milk and meat to the outside of itself. It must eat these foods. Then they are changed and become part of the animal. Plants also need to use food for growing. All living things grow bigger in this way.

There is another way in which you could tell that a snowman does not grow the way living things grow. The snowball gets bigger and bigger, but it cannot change into a snowman by itself. You have to put on its head and arms and make its face. A snowman cannot change and make new parts by itself as livings things do.

You have probably seen how some living things change as they grow. Perhaps you have had a kitten or a puppy that has grown up into a big cat or dog. Or perhaps you have planted a garden and watched flowers and vegetables grow from the tiny seeds that you put into the ground.

Animals and plants have many different ways of growing. In this unit you will learn about the changes that some kinds of animals and plants make when they grow.



This black snake has just molted its skin. A snake may molt its skin several times a year.

What happens when animals grow?

One day while Nancy was looking at some caterpillars that had been brought to class, she called out, "Come and look at this."

A group of boys and girls gathered around the caterpillar cage. To their surprise, the skin of one of the caterpillars had split open and the caterpillar was coming out! Slowly it crawled out of its skin and stretched itself out on a leaf.

The children had watched one of the most interesting things that happen to a caterpillar while it is growing. Our skin grows larger and larger as we grow, but the skin of a caterpillar does not grow bigger. When a caterpillar gets so big that its skin is too tight, the old skin splits. Out comes a larger caterpillar with a new and larger skin. When a caterpillar sheds its old skin like this, we say that it *molts* its skin.

Some other animals molt, too. Snakes molt their skins several times a year even when they are full-grown. Birds molt their feathers several times a year.

If you have ever found a tadpole in a pond in the spring and kept it where you could watch it grow, you know what happens. After many weeks the animal changes from a wiggling tadpole that lives in the water to a frog or toad that hops about on land.

The frog or toad seems almost to change from one kind of animal into another. Some animals make surprising changes. Other animals just get bigger and bigger without changing very much. Fish and reptiles just grow larger. They do not change in the strange ways that caterpillars and tadpoles change as they grow.

Birds go through some changes as they grow. A baby chick is covered with soft down. It is no larger than your fist, but you can tell that it is a young bird. When it grows up, it is covered with feathers and it has a red comb on top of its head. Some mammals change as they grow, too.

Can you think of other ways in which animals change as they grow? Suppose your teacher wrote this question on the board, "What three very important things happen when animals grow?" How would you answer it?

Here are three things that one class agreed on.

1. Animals get bigger when they grow.

2. Animals may add new parts to themselves when they grow.

3. Some animals change so much while they are growing that they look like different kinds of living things at different times during their lives.

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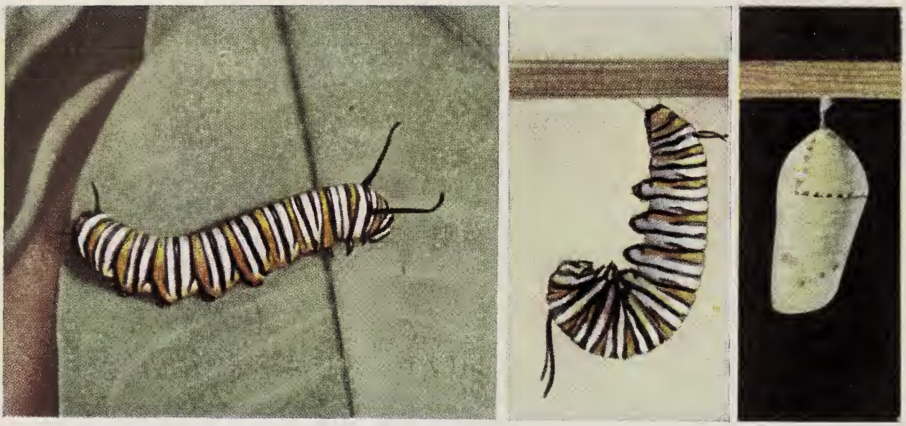
1. *Read again the sentences numbered 1, 2, and 3 above. Then think of one or two changes in some growing animals to show what each sentence means. Try to think of things that are not told in your book.*
2. *How have you changed since you were two or three weeks old? Think of all the changes you can.*



How do insects grow?

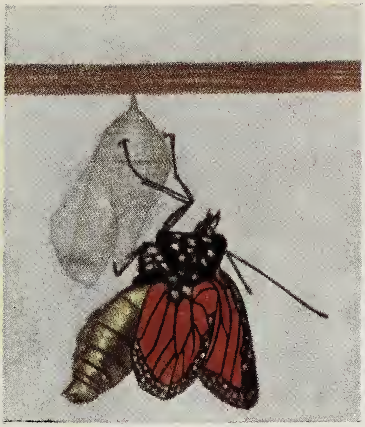
Of course, the class was keeping close watch on the caterpillars in the cage. One was a striped caterpillar that Peggy had found on a milkweed plant. Milkweed was the only food that this kind of caterpillar would eat. The pictures on these two pages show you what the striped caterpillar did.

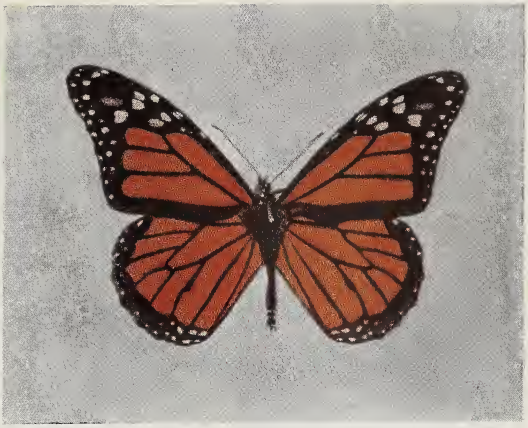
For several days the caterpillar did almost nothing but eat. Peggy had to bring milkweed leaves every day. But one day it stopped eating and crawled up the side of the cage. Then it crawled along the underside of the board that covered the cage. It seemed to be looking for a hiding place. At last, it stopped and began to spin some silky threads that stuck tightly to the board. Then it fastened one end of its body to these silky threads and let the rest of its body hang down.

The caterpillar hung there for almost a day. The class watched closely, but it was not until the next morning that they saw what had happened. To everyone's surprise, they saw something that was not a caterpillar. There, hanging from the board, was a beautiful green case with gold spots on it.

This case did not look at all like the black and yellow caterpillar. It did not even look alive. It was hard and almost like a shell. It was no longer a caterpillar. It was a *chrysalis.*

"Well, I wonder what's going to happen next," said Nancy, as she looked at the chrysalis. "We will have to watch the green case carefully to find out."





For about two weeks the chrysalis hung there. Slowly the case changed color and became dark brown. Then it began to get so light-colored that the boys and girls could almost see through it.

And at last they saw the most surprising change of all. The case began to split open, and out came an insect. It was a beautiful butterfly.

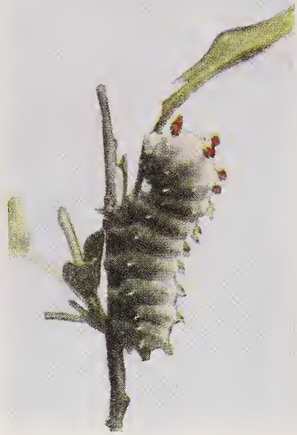
At first, the wings were wrinkled and folded together. And they looked moist as if they had been wet. After a while the butterfly began to stretch them out and to open and close them. The boys and girls could see that the wings were drying and getting stiff. By the next morning the wings were full-sized, and the butterfly was flying about in the cage.

The butterfly did not grow larger. Soon after it came out of its case, it was as large as it would ever be. Of course, the boys and girls wanted to know the name of this butterfly. It is called the Monarch butterfly.

You have just learned how the Monarch butterfly grows. You have read about three *stages* of its life—the caterpillar stage, the chrysalis stage, and the butterfly stage. But where did the caterpillar come from?

If you look at the leaves of milkweed plants, you may find some little brown or green dots about the size of pinheads. These dots are eggs laid by a Monarch butterfly. The caterpillar that Peggy brought to school had hatched from an egg like one of these. Of course, it was only a tiny thing at first. But it ate and ate and grew and grew. It molted its skin two or three times before it made a chrysalis.

One morning Henry brought a big caterpillar to class. It was almost four



inches long. It was bluish-green with knobs of different colors sticking out from it. Henry put it in the cage for the class to watch.

One day Henry noticed this caterpillar doing something that the caterpillar of the Monarch butterfly had never done. It was moving its head around, and a silk thread was coming from its mouth. As the caterpillar moved its head, it threw the silk around its body. Soon it was covered with so much silk that it could not be seen. The caterpillar was making a *cocoon* for itself.

The cocoon made a warm covering for the caterpillar. This kind of caterpillar takes all winter long to change. And while it is changing, it needs a warm cover. In the cocoon the living caterpillar slowly changes into the head, body, feelers, legs, and wings of an insect. But it is not a butterfly. It is a *moth*.

Moths are very much like butterflies, but they usually fly at night. They also have heavier bodies than butterflies, and their colors are not so bright as the colors of butterflies. Moths keep their wings out flat when they are resting on something. Butterflies hold their wings straight up and together when they are at rest.

The pictures on these pages show you what this moth looks like and how it grows. It is called a Cecropia moth. It begins life as an egg, just as a butterfly does. And it molts its skin while it is a caterpillar.

The four stages of a butterfly's life and of a moth's life make one of the most interesting stories about how living things grow. First, there is an egg. This hatches into a caterpillar,

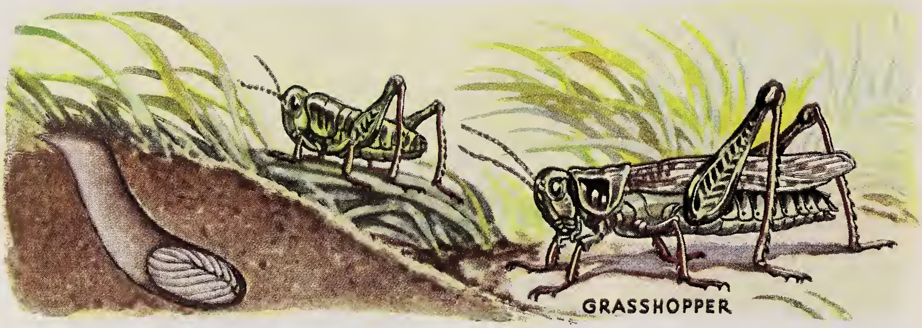
which molts as it grows larger. A moth caterpillar spins a cocoon, and a butterfly caterpillar makes a chrysalis. From the chrysalis comes a butterfly, and from the cocoon comes a moth. The butterfly and the moth are both as big as they will ever be as soon as their wings are dry.

Bees, ants, and flies are some of the other insects that have four stages to their lives. Eggs of honeybees hatch in about three days. The bee is then just a tiny wormlike animal. In a few days it spins a thin cocoon. Several days later, the bee hatches into a full-grown bee.

The common housefly takes about eleven days to change from an egg to a full-grown fly. A housefly is like a butterfly. As soon as it has wings, it is as large as it will ever be. A little fly does not grow to be a big fly.

All insects go through changes as they grow up, but they do not all have four stages in their lives as the butterfly and the moth do. Look at the pictures on page 190 to see how some other insects change as they grow.

In late summer and early autumn, the grasshopper lays a little case full of eggs in the ground. In the spring, the eggs hatch out into little grasshoppers. They have small bodies, long legs, and no wings at all. After eating grass for a few days, they molt their skins just as caterpillars do. They molt their skins five times while they are growing. After the fifth time they are full-grown insects with wings. Look at the picture at the top of page 190. This shows the three stages that a grasshopper goes through while it is growing from an egg to a full-grown grasshopper.



A cricket is another insect that grows up in the way that a grasshopper does. A cricket, too, has only three stages in its life. First, there is the egg. Then there is a young cricket with no wings. After molting several times, the cricket is full-grown and has wings.

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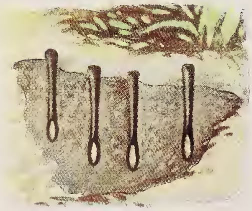
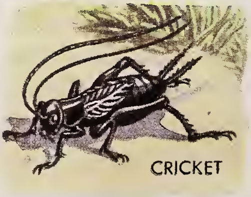
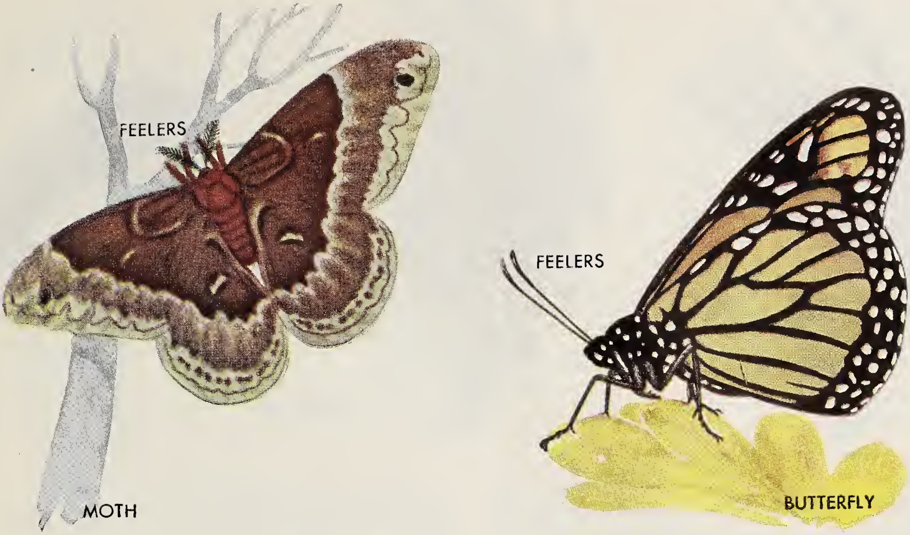
1. *Put these words in the right order to show how a butterfly grows.*
   Chrysalis *Egg* *Butterfly* *Caterpillar*
2. *What stages do grasshoppers and crickets go through during their lives?*
3. *Why does a caterpillar need to molt its skin?*
4. *Which changes more as it grows, a cat or a butterfly? Tell why you think so.*
5. *What new parts does a grasshopper add while it is growing?*
6. *Finish these sentences.*
   A butterfly caterpillar makes a ____________.
   A moth caterpillar spins a ____________.
7. *Which grows more rapidly from an egg to full size, a grasshopper or a housefly?*







Here is another way to tell butterflies from moths. Look at their feelers or antennae. Butterflies have long thin antennae. Moths' antennae look like little feathers.

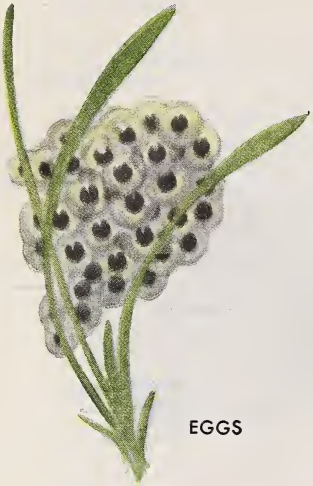
How do amphibians grow?

EVERY DAY the boys and girls spent much time studying the animals in their aquarium. Fish darted in and out through the plants. Tadpoles swam around with their wiggling tails. The class enjoyed looking at the tadpoles because they could see that the tadpoles were changing. Two little legs had grown out from their bodies. And their tails seemed to be getting shorter, too.

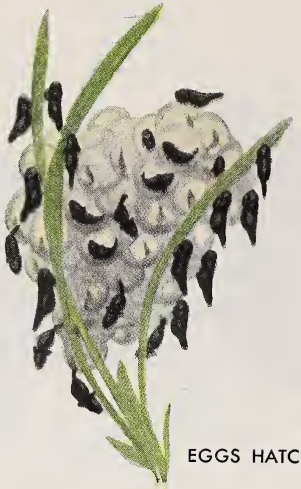
The life story of a frog is just as interesting as the story of an insect's life. In the spring, the mother frog lays her eggs in a pond or quiet stream. She may fasten them to the stem of a water plant or to a dead tree branch in the water, or she may just let them float. She lays hundreds of eggs all together in a kind of jelly, as you see in the picture on page 192.

If you look at one of these eggs, you can easily see a little black dot in it. As the bright spring sun warms the water day after day, the black dot becomes larger. At last, you can see it move. Before long, that black part wiggles loose from the mass of jelly. A tiny tadpole has hatched from the frog egg.

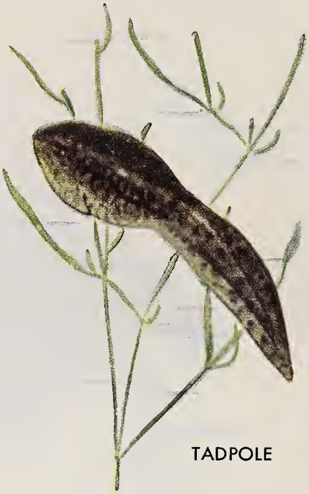
Almost as soon as the tadpole is hatched, little fringes begin to grow



EGGS



EGGS HATCHING



TADPOLE

on each side of its head. These are gills. The tadpole breathes with them just as a fish breathes with its gills. Slowly this little animal grows bigger. In a few weeks it makes another change. Its two hind legs grow out.

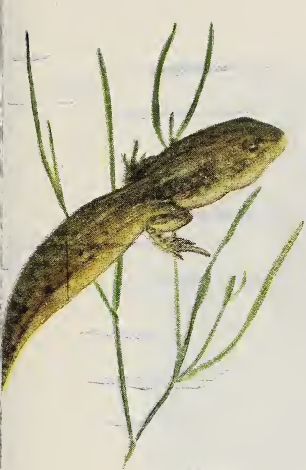
The children watched the tadpoles closely. They wanted to see how the tadpoles changed so that they could live on land. The little animals already had two hind legs. Perhaps you think the next change was getting two front legs. But it was not. The tadpoles pushed one front leg out first and then swam around with three legs.

The class knew that another leg was coming, for they could see it folded up under the skin. And then, after a time, out came the other front leg. Now the tadpoles had four legs, and they went swimming around with their tails wiggling and their legs hanging down.

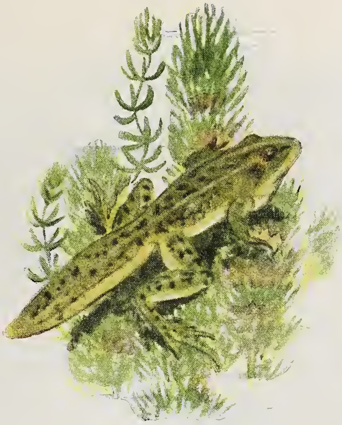
All this time their tails had been getting shorter and shorter. At last, they were just little stubs. The tadpoles were getting to look more and more like little frogs.

Changes also had been going on inside the bodies of the tadpoles. They were losing their gills, and they were growing lungs. With these lungs they could breathe air on land. One day the class saw one of the little frogs climb slowly out on a block of wood that was floating in the water. There it sat, looking around with its funny little popeyes. The tadpole had become a frog!

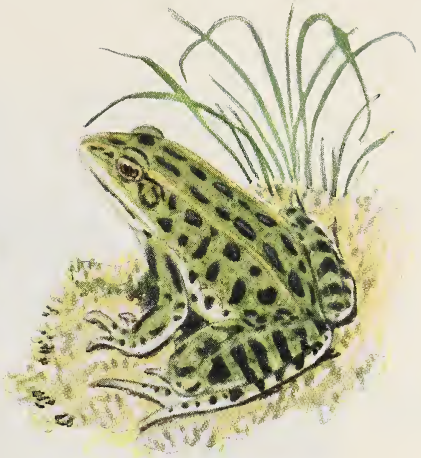
Do you think it was now a grown-up frog? Not at all. It was only about an inch and a half long. You know that many frogs are much larger than that.



TADPOLE



TADPOLE



FULL-GROWN FROG

Of course, it grew bigger and bigger as the days and weeks went by. But it did something else while it was growing. It did the same thing that the caterpillar did. It molted its skin, and this is the funny way that it did it. The old skin split down the middle of the back and the middle of the front. It also split along the tops of the four legs. Then the frog wiggled and wiggled to get out. It had to pull its front legs out and its hind legs out. Frogs molt their skins in this way several times while they are growing.

Some kinds of frogs grow to full size much faster than others. And some kinds of frogs are much larger than others. Bullfrogs grow to be great big fellows that weigh two or three pounds. They are tadpoles for more than a year. After that, it may take them two or three years to grow to full size. But some frogs hatch in the early summer and are full-grown by the time winter comes.

One day while the class was learning all these things about frogs, Nancy said, "Frogs are amphibians, and so are toads. But I never saw a toad in the water."

"I have," said John. "I've seen them in the water in the spring when I was collecting frogs' eggs. But I never saw them in the water any other time."

Toads go to the water only in the spring, and they go then to lay their eggs. Toads' eggs are black. They are laid in long strings of grayish jelly. The picture on the next page shows you some strings of toads' eggs. Perhaps John had seen toads' eggs, but did not know what they were.

Toads' eggs hatch out into little toad tadpoles and then change into little toads in almost the same way that frog tadpoles change into frogs.

1. *Here are some of the changes that frogs make while they are growing. Put them in the order in which they happen.*
   - *Come out of the water*
   - *Get hind legs*
   - *Get front legs*
   - *Molt their skins*
2. *Which is older, a tadpole with hind legs or one with front legs?*
3. *What hatches from a toad egg?*

How do other groups of animals grow?

MAMMALS, BIRDS, reptiles, and fish change while they are growing. But they do not change as amphibians and insects do. They do not change so much that they seem to change from one animal to another. Snakes molt their skins while they are growing, but they do not change their looks. They look like snakes from the moment they are born or hatched. A fish looks like a fish as soon as it hatches.

When you see a baby bird, you cannot always be sure what kind of bird it is. Many kinds of baby birds do not look much like their parents. Have you ever found a nest of baby robins and watched the young birds grow? You knew that they were robins because you saw the mother

feeding them worms. But if you found one of the little birds away from its nest, you might have wondered what kind of bird it was.

Bluejays and robins have no feathers or other covering on their skins when they hatch. They stay in the nest and are sheltered until they have feathers. Robins grow feathers in about eleven days. Even a young robin that has feathers and has left its nest does not yet look exactly like its parents. At first, it has no tail feathers. So it has a hard time flying. Its breast is speckled for a while after its tail feathers grow. It is speckled until the young robin is almost full-grown.

Baby chicks are covered with fluffy down when they hatch. They can run around and get their own food right away. Baby ducks and many other young water birds are also covered with down. They can go into the water to hunt for their own food almost as soon as they hatch. Most of them do not look much like their parents until their feathers begin to grow. The baby Canada geese in the picture on this page will begin to look like their parents when they are about three months old. Then they get the colors and markings that tell you what kind of bird they are.

Kittens and puppies are easy to recognize when they are tiny. You could probably tell what kind of animal most other mammals are even when they are very young. But mammals change, too, as they grow. Some change the markings of their coats. Baby lions have spotted coats like the ones in the picture on page 183. They keep these spots until they are about a year old. Then the spots disappear, and their coats are like those of their parents.

Young deer, or *fawns*, as they are called, are spotted, too. These spots make it very hard to see the fawns among the leaves. When the fawns get their first winter coats, they lose their spots and have coats of the same color as full-grown deer.

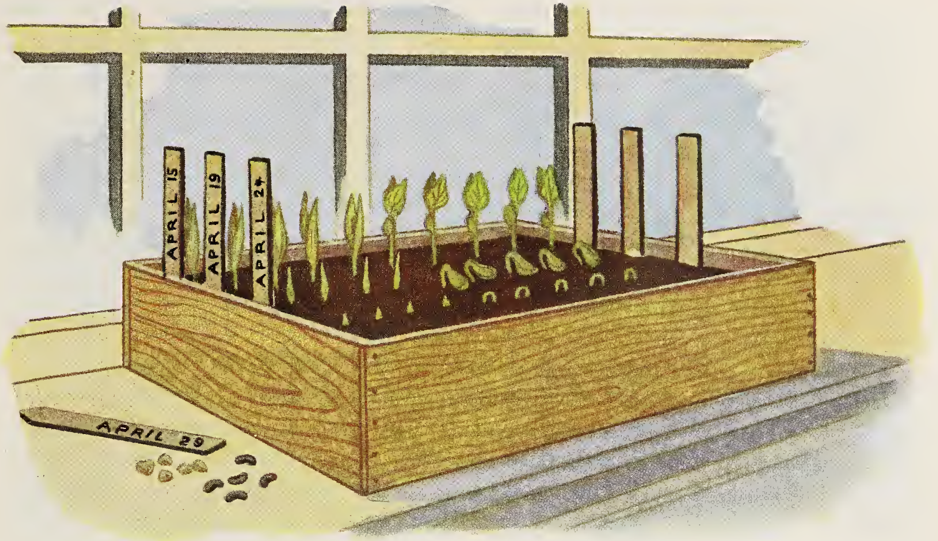
Some mammals change more than this when they grow. You probably would not know a baby black bear if you saw a very young one. People do not often see the very young black bears. They are born in the winter and stay with their mother in the den, where she is spending the winter. When the little bears come out in the spring, they are about three months old.

But when the black bears were born, they were only about the size of a squirrel and had almost no hair. Their eyes were closed, and the mother bear had to give them a great deal of care. They did not look much like the bears that you see at the zoo.

Some other mammals have no fur when they are born. Did you ever find a nest of tiny mice or rats? The small, pink, naked animals have to grow and change a great deal before they look like mice.

You yourself have changed very much since you were a month old. If you look at your baby pictures or at the clothes you wore, you will probably think, "I've certainly grown a lot." You are taller, and you weigh more. You have grown stronger. Your muscles are larger. Your bones are larger and stronger. You did not have any teeth when you were a month old. Since then, you have grown one set of teeth, and now you are getting another. As you get older, you keep on growing and changing.

1. *Which of these groups of animals change most as they grow?*
   Insects Birds Mammals Fish Amphibians
2. *What changes do fish, birds, and mammals make as they grow?*



How do plants with seeds begin to grow?

It is easy to watch plants change as they grow if you follow these directions. You will need a box of good soil about four inches deep. Get a handful of bean seeds and a handful of corn seeds. In one end of the box, plant one or two corn seeds. In the other end, plant one or two bean seeds. Then every two or three days for two weeks plant a few more of the two kinds of seeds. Keep the seeds watered and in a sunny place in your schoolroom.

Push little flat sticks part way into the soil beside the seeds. On each stick write the date so that you will know which seeds were planted first. By the time you have planted the last seeds, you will have plants of several different sizes.

Now suppose you try to find out how bean and corn plants grow from the little seeds you planted. If you study the structure of the seeds, you can find out. Soak some seeds in water overnight. Then you can take them apart or cut them open easily, so that you can see the structure of the seeds.

You will learn several things when you take a bean seed apart. You will find that there is an outside coat, like a skin, that easily slips off the wet seed. You will learn that you can split the seed into two parts like the ones in the picture on page 198. When you have done this, study these parts carefully and tell what you see. Use a magnifying glass if you have one.

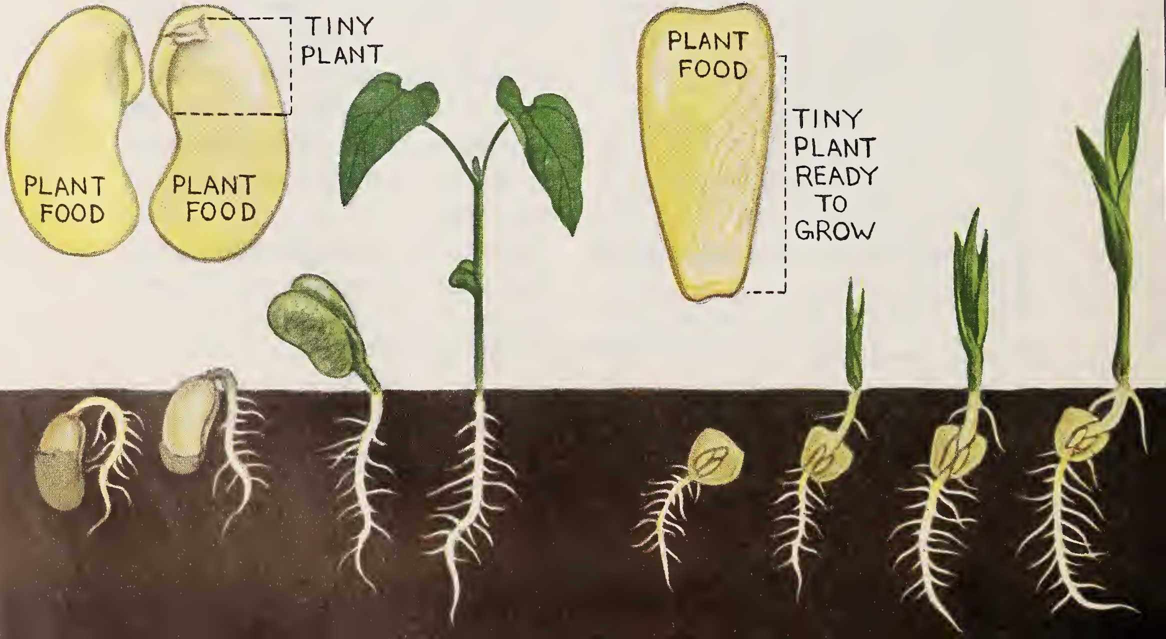
If you look carefully, you will find something that looks like two little leaves near the end of one half of the bean. There is another part that looks like a tiny stem.

When you look at the corn seed, you will find that it cannot be split in two. So you will have to cut it in two from top to bottom. Down near the pointed end of the corn seed there is a part that looks different from the rest of the seed. You will have to look closely to see it. This part is the beginning of a tiny corn plant. Did you find those parts in the seeds you looked at? Do you see them in the pictures on this page?

The parts you found in the bean seed and in the corn seed are tiny plants all folded up and ready to grow. The rest of the seed is food for this tiny plant to live on while it is beginning to grow. A seed is really a baby plant with the food that starts it growing and a covering that protects it.

Now you are ready to find out just how the baby plant changes as it begins to grow. Dig up some of the plants from your box of corn and beans. Start with the ones you planted last. Be sure to take plenty of soil with them and wash the soil off after you have dug them up. In this way you will not break the roots of the plants.

Look at your plants carefully and study the pictures on this page. Then make a list of the changes in the plants as they grow taller and taller. Study each plant carefully. See how many changes you can find.



Read the questions on this page. They will help you know what kinds of changes to look for while you are watching your plants grow.

Notice, too, how long it takes a bean or corn seed to grow into a small plant with several leaves. If you plant string-bean seeds in your garden, you can probably pick some beans about seven weeks after you plant them. You can have some radishes three or four weeks after you sow the seeds. Lettuce grows in about six weeks. But if you want to grow some jack-o'-lanterns for Halloween, you will have to sow the seeds about fifteen weeks before you want to pick the pumpkins.

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1. *Why did you start growing some bean seeds and some corn seeds on several different days?*
2. *Which part of the plant grows out of the seed first—the root that goes down into the soil or the stem that grows up out of the soil?*
3. *What is happening to the seeds of the plants that have been growing longest? Why?*
4. *What has happened to the covering of the seed?*
5. *What has happened to the food that was inside the seed?*

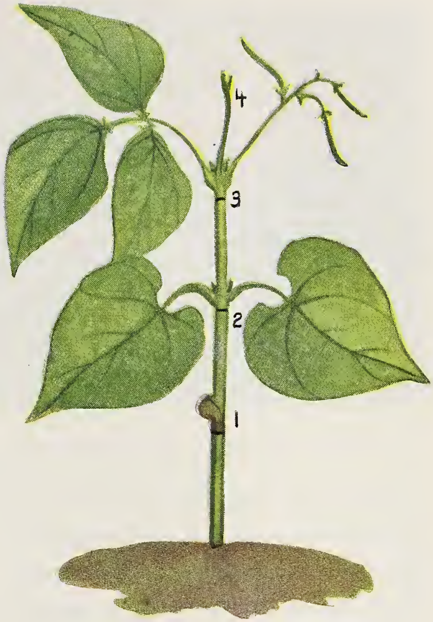
How do plants grow taller?

On his grandfather's farm John had often seen a big tree with a rusty old horseshoe nailed to it. When John's father was a boy about ten years old, he nailed that horseshoe to the tree. The tree had grown many feet taller, but the horseshoe was still the same distance from the ground. John could not understand why. He thought that the horseshoe would be moved higher as the tree grew taller.

Do you know why the horseshoe stayed the same distance from the ground? You can use a bean plant from your box of corn and bean plants to help you find out for yourself how trees and other plants grow taller. Choose one of the young growing bean plants and mark the stem between each pair of leaves as shown in the picture. As the bean plant grows taller, mark the stem just below each pair of new leaves.

Does the stem get taller by growing at the bottom or at the top? Do the marks, numbered 1, 2, 3, and 4 in the picture, get farther from the soil? If you do this experiment, you will find that the marks stay in the same place. The stem of the bean plant gets taller by growing at the top.

The horseshoe that John's father nailed to the tree stayed the same distance from the ground even



though the tree grew taller. Does this tell you anything about how trees grow tall? Do you think they grow longer all the way along the stem, or *trunk*, or just at the top?

If you look at some twigs and branches in the winter or early spring, you can find out what happens when they grow longer. The picture at the bottom of this page will help you, too. Look at the end of the twig, and you will see the bud. If you open one of these buds, you will find a tiny stem with leaves packed tightly inside. When spring comes, the tiny stem and leaves begin to grow.

When the bud grows, it leaves a ring of rough bark around the twig. If you measure from the bud to the ring below it, you can see how far the twig grew last year. If you measure from this ring to the next ring, you can tell how much the twig grew two years ago. Now you can understand why the horseshoe never got any farther from the ground. The trunks of trees and the stems of other plants get taller by growing out from their ends. The branches of trees and other plants get longer by growing out from their ends, too.

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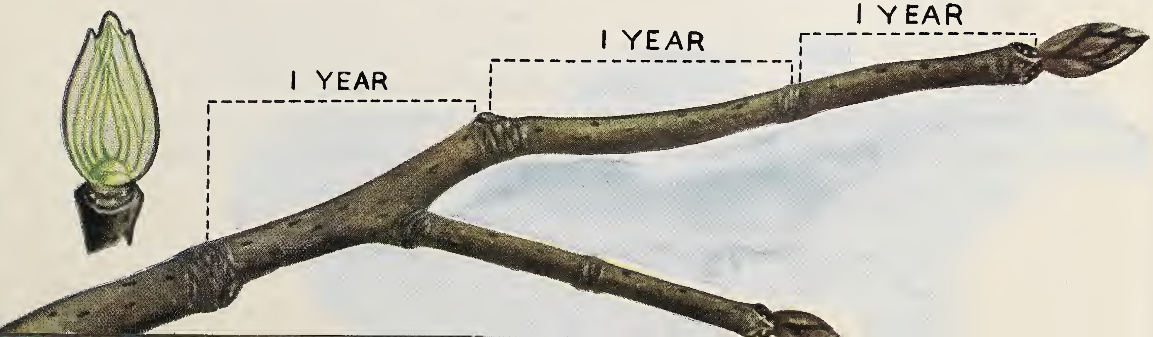
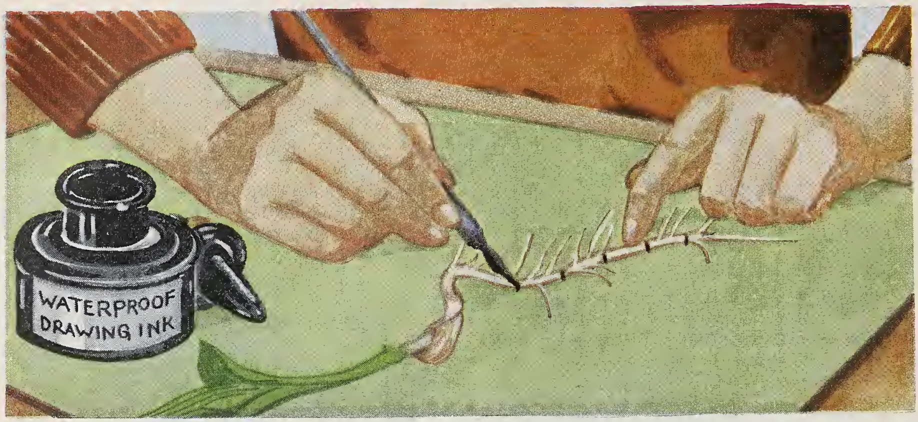
1. *How can you tell how old a twig is?*
2. *How do plants grow taller? How can you show this?*
3. *If you hang a swing from the branch of a tree, will the swing get farther from the ground as the tree grows taller? Why?*





How do the roots of plants grow longer?

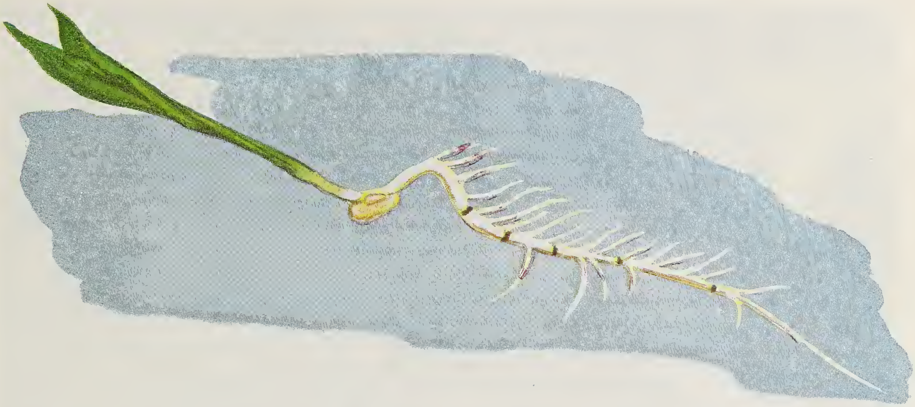
Now you can use some of your bean or corn plants to help you find out how the roots of plants grow. Take two or three of your biggest plants and pull them up carefully so that you will not break the roots. Wash the roots clean. Get a kind of ink that cannot be washed off by water and make marks on the roots. Begin very near the tip. Put a ruler alongside each root and make the marks the same distance apart all the way up to the top of the root. Now put the plants into a box of moist sawdust. It will be easy to pull the plants out of the sawdust to study them again. Be sure to keep the sawdust moist.

Some boys and girls in a science class tried this experiment once. Of course, they wondered what was going to happen to the marks. But they had to wait more than a week for the plants to grow. At last, the day came to pull them up and look at them. At first, no one saw anything interesting. The marks were all there. Then Charley noticed something.

"This root has grown way out beyond the bottom mark," he said.

By this time Peggy had noticed something else. "The two marks nearest the end of the root are farther apart," she said. "But the other marks are almost exactly the same distance apart as when we made them."

The picture on the next page shows what the boys and girls saw. What does it show about how roots grow? The class decided that roots get longer by growing at the end. The last mark they had put on each root had been almost at the tip. Now the



mark was much farther back from the tip. The root had grown an inch longer at its end. Between the two lowest marks it was a little longer than it had been. But the other marks on the root were almost the same distance apart as when they were made.

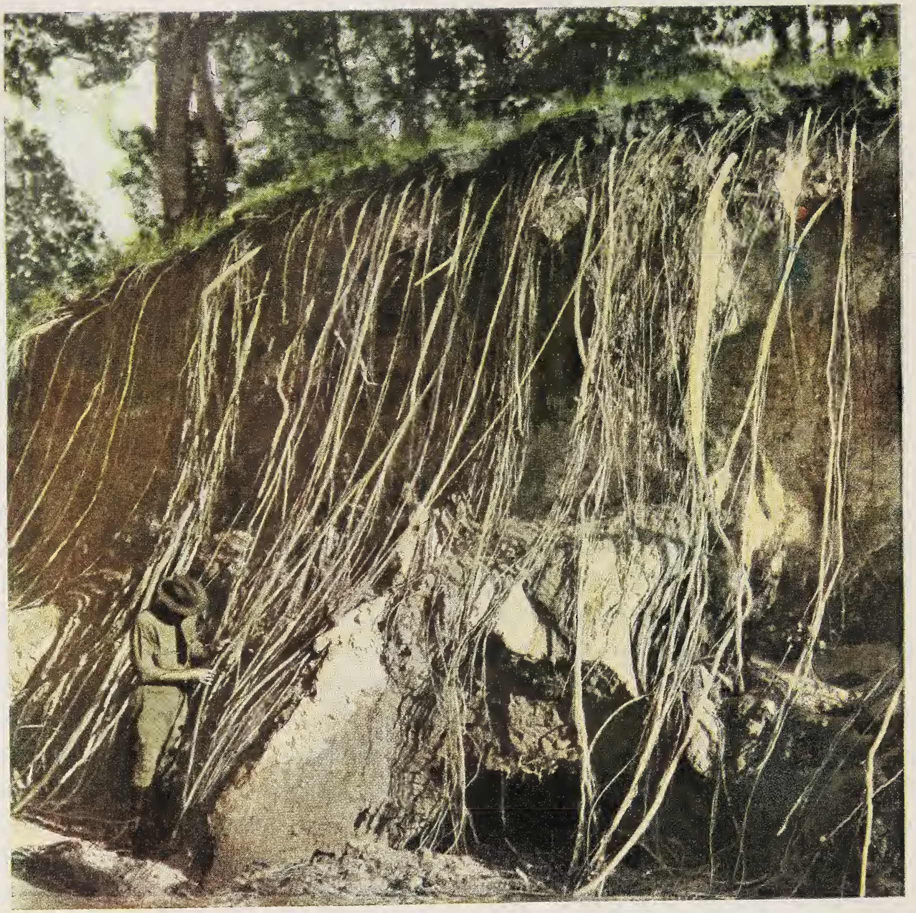
Roots can grow like this until they are very long. Sometimes the roots of a tree grow to be more than 50 feet long. Some of the roots of a tree in your yard may be growing under your neighbor's lawn.

Roots have branches, too. The branches also get longer by growing out at their tips. When you pull up a large plant, you see that it has many, many roots. They branch and grow out in all directions from the plant. If you could take all the roots of one full-grown wheat plant and put them together in a string, you might have a string that is several hundred feet long.

A sugar beet may send roots down five or six feet into the soil. One scientist measured all the roots of an oak tree. The tree had 450 feet of roots. You probably never thought that such a big part of a plant may be under the soil.

Did you ever try to pull up different kinds of weeds? It is easy to pull up some kinds and hard to pull up others. If the ground is dry, it is almost impossible to pull up a dandelion or a burdock. But plantain and chickweed pull up easily. If you can do so, dig up four or five kinds of weeds and study the roots.

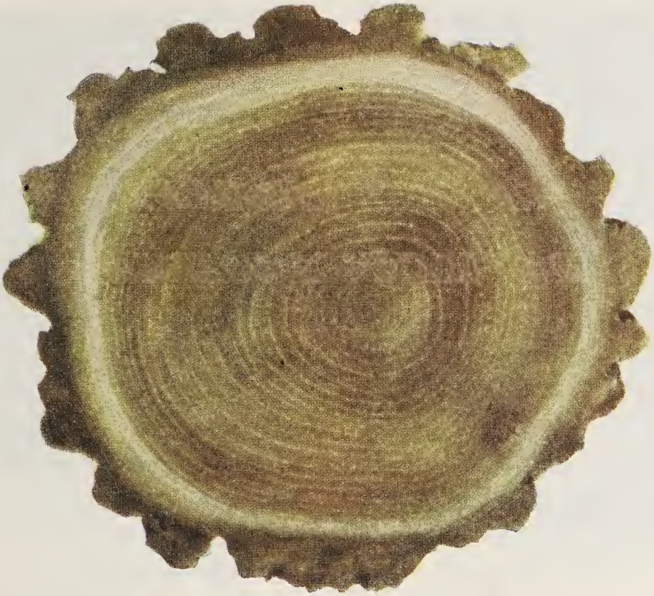
If you dig up a dandelion, you find that it has one big main root that goes straight down. So does a burdock. But goldenrod and daisy plants have a bunch of slender roots that grow out sideways. Tree roots grow in the same two ways. Some trees, such as the white oak, have a big



When the soil is cut away, you can see how long the roots of the trees are.

main root. It goes straight down. Of course, it has roots that grow out sideways, too. Other trees do not have a main root that grows straight down. All their roots grow out sideways.

It is a great help to plants to have roots that can grow far down and out in all directions. These roots help plants get the water and materials for making food. Later in your science work, you will learn how roots take in water and materials for making food from the soil. You will also learn how plants make food from these materials.

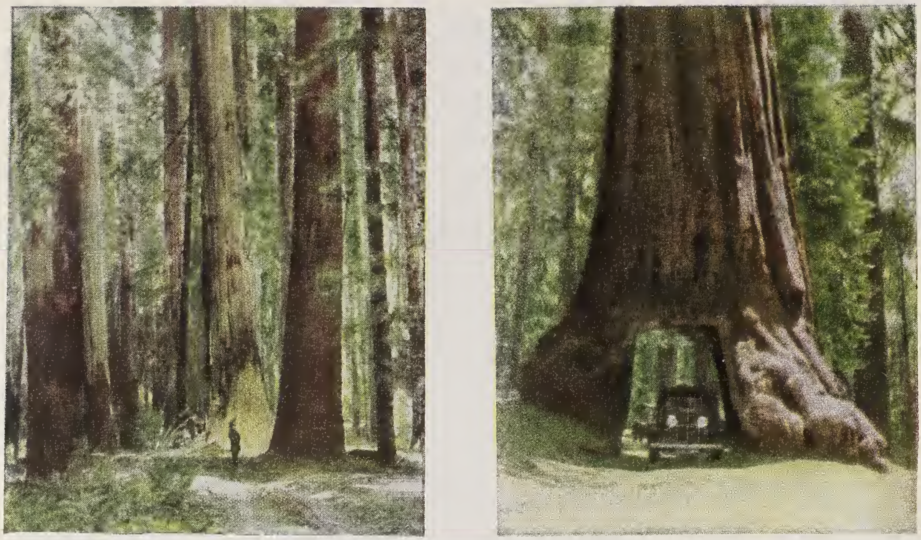


How do the stems of plants get thicker?

Of course, you know that the stems and even the roots of plants get thicker as well as longer. But you may be surprised to learn how they get thicker. Can you find a piece of tree trunk that has been sawed across? Perhaps you have a woodpile at home where you can find a piece like this. Get a piece that has not been split.

Two of the boys in the science class said that they could find some pieces to bring to school. The next day the boys and girls looked at the structure of the inside of the branches and the trunk of a small tree. The picture on this page shows what the inside of a tree trunk looks like. Do you see the rings of light-colored and dark-colored wood? The rings show you how the tree grows thicker. It grows thicker by adding layers of wood around the outside just underneath the bark. Each ring is made of two layers of wood. Branches of plants grow thicker in this way, too.

The layer of wood that grows in the spring looks light-colored. The layer that grows in the summer looks dark. In this way a light layer and a dark



These huge trees in California are hundreds of years old.

layer are added to the tree trunk every year.

What can the layers tell you about a tree? Do you see that they can tell you how old it is? Every year one ring of new wood is added. Each ring has a dark layer and a light layer. The class counted the dark layers in one piece of tree trunk that the boys had brought. The tree was twenty-eight years old. Another tree was twenty years old. Count the dark layers in the picture on page 205. How old was the tree?

Perhaps you are wondering how many years trees keep on making rings like this. Some trees grow more slowly and live much longer than others. They can keep on making rings for hundreds of years. But as they grow older, they make new wood more slowly. So the rings are thinner.

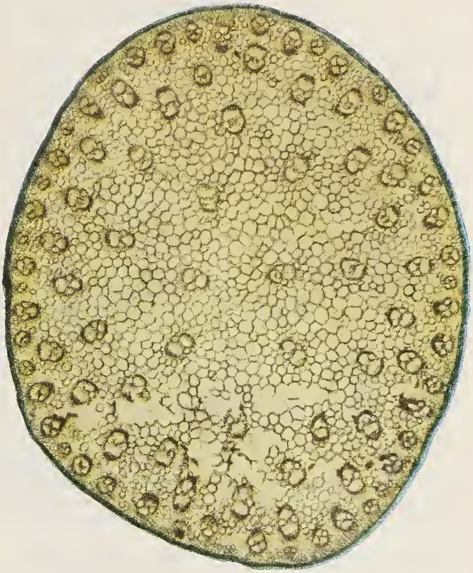
Do you live in the western part of our country? Or have you taken a trip to see the big trees in California? Perhaps you have driven through a tunnel that was cut right through one of these big trees.

It takes a long time for a tree to grow big. But it can be cut down in just a few minutes. Think about that if you see someone chopping down a fine large tree. Probably that tree has been living longer than you have. If it is allowed to go on growing, it will give shade on the hot days. It will make homes for birds. Its roots will help keep the soil from being blown and washed away. It will help make our country a more beautiful place to live in.

Some parts of the world have been almost ruined because all the trees were cut down. Then there were no tree roots to keep the soil from being blown or washed away. When all the good soil was gone, the people could not grow crops for themselves or their animals. Soon very few people could live there. We must be very careful that this does not happen in our country. You can see why we must save, or *conserve,* our trees and use them wisely.

Many plants do not grow in the way that trees grow. They do not get thicker by adding layers of wood around the trunk and branches. Corn is a plant like this. The boys and girls in one science class decided to see what the inside of a cornstalk looks like. They cut a cornstalk into pieces crosswise. Soon Mary said, "I can't find any rings inside like the ones we saw in the tree."

Mary was right. There are no rings in the cornstalk, as you can see from the picture on this page. The corn plant gets thicker by growing all through the inside. This shows us another way in which plants grow thicker. Not all kinds of plants add new layers around the stem and branches. Look again at the picture on page 205 and compare it with the picture on this page. Do you see how differently the stems of the two plants grow thicker?



This is how the inside of a cornstalk looks when you see it through a microscope.

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1. *What are the two different ways in which plants grow thicker?*
2. *How can you tell how old a tree was when it was cut down?*
3. *Why must we conserve our trees?*

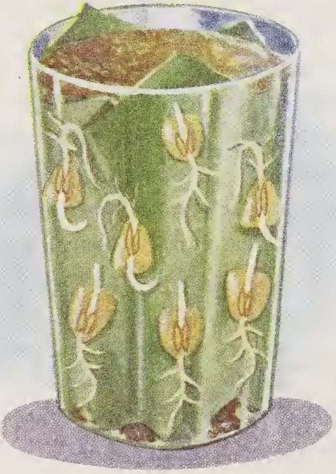
In what directions do the parts of plants grow?

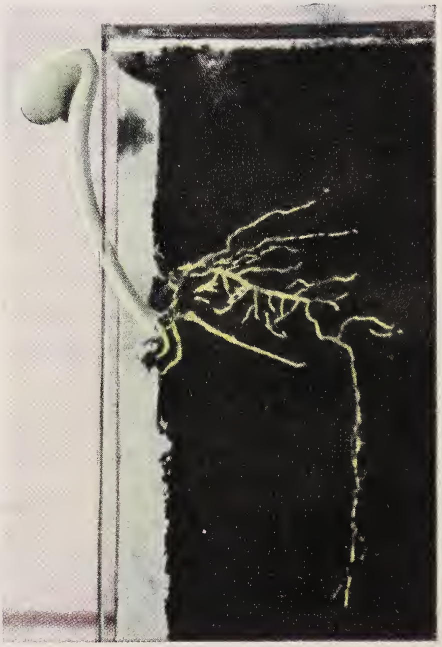
WHEN YOU PLANTED your corn and bean seeds, did you look to see which was the bottom and which was the top of the seed? No, you probably just put the seeds into the soil without thinking about that at all. When the seeds started to grow, the roots of all the plants grew downward into the soil. And the stems grew up and soon were above the soil. Do roots always grow down? Do stems always grow up?

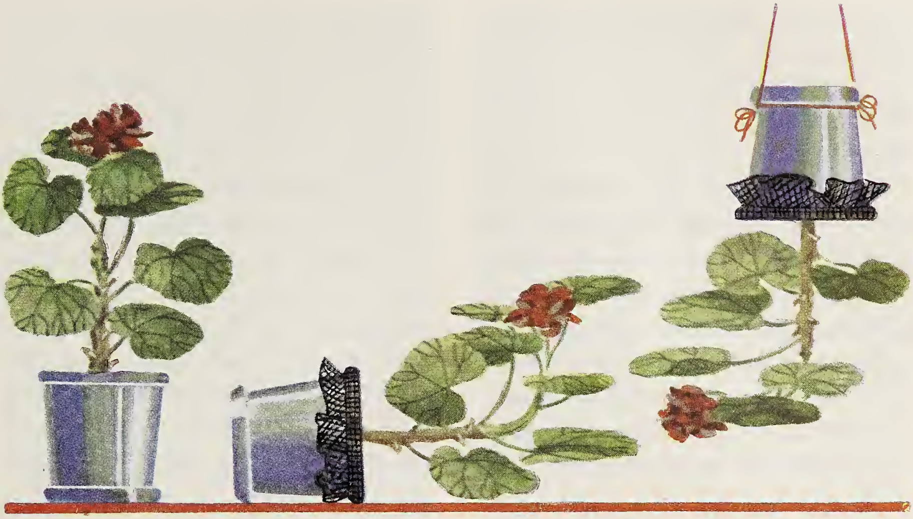
Here is an experiment that will show you something about how roots grow. Line a glass with moist blotting paper as shown in the picture on this page. Then fill the glass with moist sawdust or sand. Soak a dozen corn seeds overnight. Then put them between the sides of the glass and the blotting paper. Plant the seeds about an inch apart. Put the glass in a warm place and keep the sawdust or sand moist but not too wet.

After a few days look at the seeds. Which way do the roots of the little plants grow? After the roots have grown about an inch long, take half of the plants out of the glass and put them back so that the roots point upward. Watch the roots for two or three days. What do they do?

The roots of the plants that were left in the glass kept growing downward.







When the roots of the other plants were turned so that they pointed up, they turned around and began to grow downward again. No matter in what direction a root may point when it starts growing, it will always turn and grow downward.

Now look again at the plants in the glass. What has happened to their stems? The stems of the plants that had been left in the glass kept on growing upward. But the stems of the plants that were turned down have turned around and are now growing upward again.

In the picture on the right on page 208 is a young bean plant. After it had grown awhile, it was turned on its side. What happened to the roots and the stem of the bean plant?

Here is another experiment that will show you how stems grow. Get three small geranium plants. Choose plants that are growing well in small flowerpots. Cut two pieces of wire screen to fit around the stems of two of the plants and over the tops of the flowerpots. Fasten the screen on with wire. This will keep the soil from falling out during the experiment.

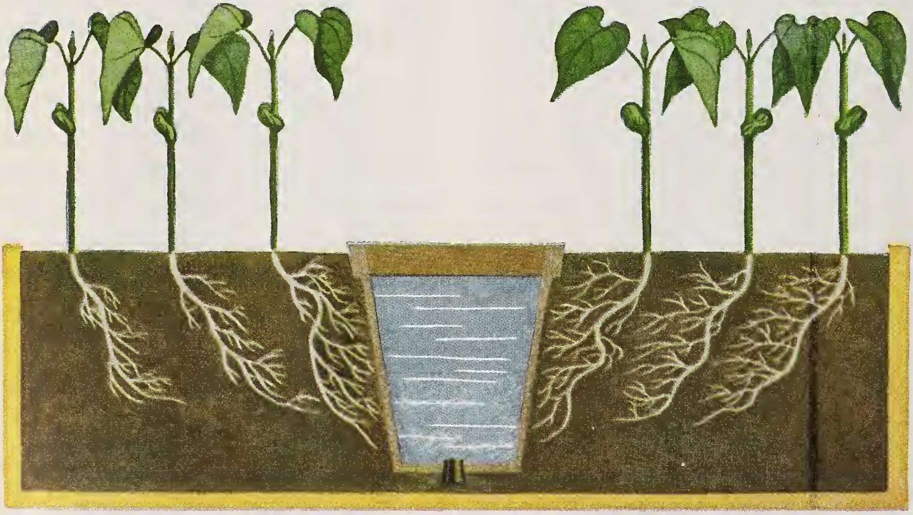
Water the plants. Now take one of the plants with the screen over it and lay it on its side. Hang the other one up so that its stem is pointing downward, as the picture on this page shows. Keep the third plant with its stem pointing up.

Water all three plants whenever they need it and watch them for several weeks. In what direction does the stem of the plant that was pointing up grow? What has happened to the stems of the other two plants? They have turned and are now growing upward.

If you did the experiment with the corn seeds, you found out that roots always grow downward. This helps them get water and other materials from the soil. Roots do another interesting thing that helps them get water. If another part of the soil has more water than the part where the plant is growing, the roots will grow toward the part where there is more water.

Sometimes water is deep down in the soil. Then the roots keep on growing down until they reach the water. Sometimes there is water just on one side of the roots. Then the roots will grow toward the side where this water is. You can see that roots do this if you try this experiment. First, find a small unpainted flowerpot. Plug the drain hole with a rubber stopper and sealing wax. Set this empty flowerpot in the middle of a box about two feet square. Fill the box around the flowerpot with rich soil.

Soak some bean seeds overnight. Plant several bean seeds near the pot and several seeds farther away from it. The soil should be moist when the seeds are planted. Now pour water into the flowerpot. It will slowly pass through the sides of the pot into the soil that is near it. Do not water the soil in any other way.



Your box of soil with the flowerpot to hold the water should look like this. The beans will probably look like these plants when they are several inches high.

Now find another box of the same size. Put the same kind of rich soil in it but do not set a flowerpot in the box. Plant the same kind of seeds in this box and plant them in the same way. Water the plants by sprinkling water on top of the soil. The only difference between the two boxes is in the way the roots get water. If there is any difference in the way the roots grow, the reason for the difference will be the way the plants get water.

After the plants are several inches high, dig up some of them that are growing near the flowerpot. Be sure to notice in which direction the roots are growing. Now dig up some of the plants farther from the flowerpot. In which direction do their roots grow? Last of all, look at the roots of the plants in the box without the flowerpot. How are they different from the other roots?

You can use what you have learned to explain what happened in this story. Some people built a house in a grove of poplar trees. They put tile pipe in the ground to carry waste water from their house to the sewer under the street. After a few years they began to have trouble. The waste water would no longer flow in the pipe from the house. It even backed up and flowed out on the basement floor.

When they dug down to the tile pipe, they found that the roots of the trees had grown through the joints. The roots had grown so big that they had filled the pipe and broken some of it. Why did the roots grow into the tile pipe?

Here is another experiment. It will show you another interesting thing about the way plants grow. Find a small cardboard box just large enough to hold a shallow dish. The box should be about three inches deep. Cut a hole in one side of the box so that light can get in. Now put several pieces of moist blotting paper in the bottom of the dish. Lay a dozen or more bean, radish, or grass seeds on the moist paper. Cover the box. Be sure to use good seeds and keep them moist. In what direction do the stems grow?

If you did the experiment carefully, you found that the stems grow toward the light that came through the hole in the side of the box. If the distance is not too great, the stems may even grow out through the hole.

You can try another experiment if you have some plants. Use a small geranium or any kind of house plant. Put it in a window for a few days. Notice how the leaves turn. After most of the large leaves have turned toward the light, turn the plant around so that the leaves face the

room. Now watch the plant again. How long does it take for the leaves to turn toward the light? Try putting a whole plant in a box that has a hole in it. What happens to the leaves?

You know that plant roots will grow toward water. Now you see that plant stems and leaves will grow toward light. If a plant is shaded on one side and has the sunlight on the other side, it will grow more on the sunny side. Plants even grow with their leaves arranged to catch the most sunlight. Study the pictures on this page to see how the leaves are growing to catch the light. Then look at a vine to see how its leaves are turned to catch the light.

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1. *How can you show that the root of a plant always grows down and the stem always grows up?*
2. *How do the directions in which the roots and stems grow help plants stay alive?*
3. *Do stems of plants grow toward or away from the light?*
4. *Do roots grow toward water in soil or away from water?*

QUESTIONS TO ANSWER

1. The picture on this page shows how a mosquito changes as it grows. Find the four stages of its life.

2. Make a list of animals that change as they grow. Let each boy and girl choose one animal. Then have each one answer these questions about the animal. How does it change as it grows? What helps it grow? What food does it use?

3. Try to tell the story shown in the picture on these pages: 186-187 (Monarch butterfly), pages 188-189 (Cecropia moth), page 190 (grasshopper and cricket), pages 192-193 (frog).

4. In Unit One you learned different ways to make discoveries. Which of these ways have you used in this unit?

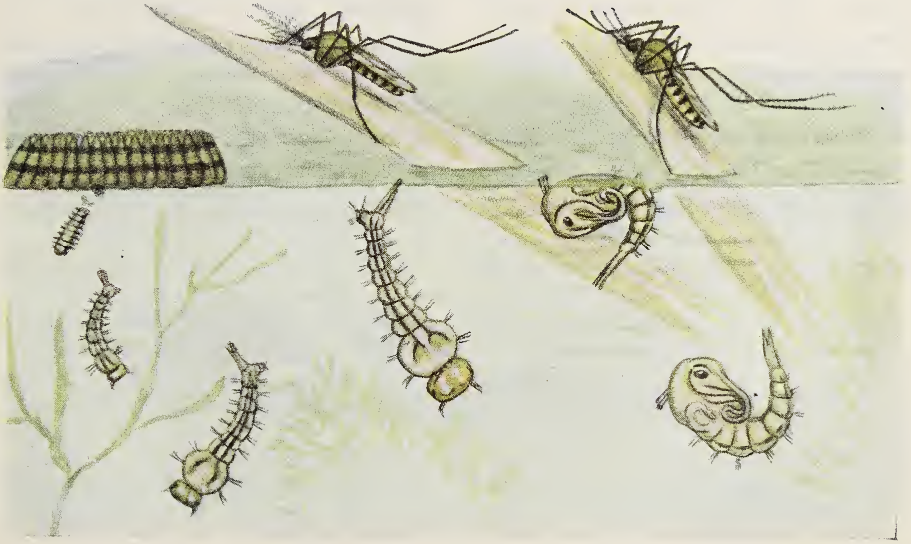
5. Where would you look to find these things—toads' eggs, Monarch butterfly eggs, grasshopper eggs, mosquito eggs, tadpoles?

6. How is the way plants grow like the way animals grow? How is it different?

7. Make a list of things that happen as a seed grows into a plant.

8. How does knowing about the structure of a seed help you understand how it grows into a plant?

9. Make a list of all of the animals and all of the plants mentioned in this unit. Then put them into the groups you learned in Unit One.



THINGS TO DO

1. Look for cocoons on trees and bushes. Keep them to find out what comes from them.

2. Bring some caterpillars to school and watch to see if they spin a cocoon or make a chrysalis. Keep the cocoon or chrysalis and find out what happens to it.

3. Examine an ant's nest. See if you can find the four stages of an ant's life.

4. Find pictures in books and magazines that show how animals change as they grow.

5. Have an exhibit of baby pets.

6. Find some young grasshoppers. Put them in a cage and feed them grass. Watch what happens when they grow.

7. Make some cuttings of house plants. Plant them in moist sand. Keep a record of how they change as they grow.

8. To see how leaves grow, draw a mark across a narcissus leaf. Measure from the bottom of the leaf up to the mark. Then measure it again in a week. What does this show you about how narcissus leaves grow?

9. Get a geranium plant. Hold a piece of paper against a new leaf and draw the outline of the leaf. Keep the drawing. In a week or so draw the outline of the leaf again. Use the same piece of paper. What does this show you about how geranium leaves grow?

10. Visit a garden or greenhouse and try to see some of the things you have learned about in this unit.

11. Try to find pictures of big trees in different parts of our country.

12. Keep a record of the way an ivy plant grows. With a yardstick measure the length of a branch. Make a drawing of it beside the yardstick. Write the date on your drawing. Three or four weeks later measure the ivy branch again. Add to your first drawing any new parts that have grown. Then write a story of how the ivy plant grew. Tell where the stem grew longer and where new leaves were added.

SCIENCE WORDS

CAN YOU SAY the word *chrysalis?* Do you know what it means? You can easily find out. Look in the list of science words that begins on this page. The word *chrysalis* is on the next page.

Notice that each word in the list is printed two times. The second time shows you how to say the word. Some of the letters have marks over them. The mark tells how the letter sounds. Look in the list below to see how each letter sounds.

Now look at the word *backbone* on this page. The slanting mark **ʹ** after *bak* is bigger than the slanting mark ʹ after *bōn*. So you say *bak* with more force than *bōn.*

a	hat, cap	ėr	term, learn	ô	order, all	ə represents	
ā	age, face	i	it, pin	u	cup, butter	a	in about
ã	care, air	ī	ice, five	u̇	full, put	e	in taken
ä	father, far	o	hot, rock	ü	rule, move	i	in pencil
e	let, best	ō	open, go	ū	use, music	o	in lemon
ē	equal, see					u	in circus

al ni co mag net (alʹni kō magʹnit), a magnet made of aluminum, nickel, cobalt, and iron. It will pick up things that are heavier than it is.

am phib i an (am fibʹi ən), a cold-blooded animal that lives in water and breathes with gills when young but that has lungs and can live on land when grown up.

an ten na (an tenʹə), a feeler on the head of an insect and some other animals.

an ten nae (an tenʹē), more than one antenna.

a quar i um (ə kwãrʹi əm), a tank or glass bowl where fish, other water animals, and water plants are kept.

ar ma dil lo (ärʹmə dilʹō), a small mammal with a hard, bony shell. It has only a little hair.

at tract (ə traktʹ), pull toward itself. A magnet attracts iron and steel.

ax is (akʹsis), a real or imaginary line around which something turns. The earth turns around an axis.

back bone (bakʹbōnʹ), the long row of bones along the back of the body.

Be tel geuse (bēʹtəl jüz), a large reddish star in the constellation Orion.

Big Dip per (big dipʹər), a group of stars in the constellation Ursa Major.

blood ves sel (blud vesʹəl), a tube in the body through which blood flows.

brain (brān), the part of the body inside the skull. It is used for thinking and for directing the other parts of the body. Nerves run to and from the brain.

car bon di ox ide (kär′bən dī ok′sīd), a gas that is made of carbon and oxygen. It cannot be seen or smelled.

car ti lage (kär′ti lij), firm, tough material that forms parts of the skeleton.

Cas si o pe ia (kas′i ō pē′ə), a constellation in the northern sky.

cen ti pede (sen′ti pēd), a small wormlike animal with many pairs of legs.

chrys a lis (kris′ə lis), a hard case made by a caterpillar to live in while it is becoming a butterfly.

co coon (kə kün′), a silky case made by a caterpillar to live in while it is becoming a moth.

cold-blood ed (kōld′blud′id), having blood whose temperature changes with the temperature of the surroundings.

com pass (kum′pəs), an instrument to tell direction.

con dense (kən dens′), change from a gas to a liquid.

con stel la tion (kon′stə lā′shən), a group of stars.

de cay (di kā′), rot or spoil.

des ert (dez′ərt), a dry region with few kinds of plants and animals.

di gest (di jest′ or dī jest′), change food in the stomach and intestines so that the body can use it.

dis solve (di zolv′), change into a liquid by mixing with a liquid. Sugar and salt dissolve in water.

ear drum (ēr′drum′), a thin part inside the ear that makes hearing possible.

e vap o rate (i vap′ə rāt), change from a liquid into a gas.

ex per i ment (eks per′i ment), test to try to find out something.

fawn (fôn), a deer less than a year old.

fer ti liz er (fėr′ti līz′ər), a material that is mixed with soil to help plants grow.

flow er (flou′ər), the part of a plant that makes the seeds.

force (fōrs), a pull or push.

gas (gas), a material like air; neither a solid nor a liquid.

ge o graph ic poles (jē′ə graf′ik pōlz), the poles at the ends of the earth's axis.

germ (jėrm), a very tiny plant or animal that can cause a disease.

gills (gilz), the parts of a fish and some other animals that are used for getting air from water.

gris tle (gris′əl), cartilage.

heart (härt), a large, hollow muscle that pumps the blood through the body.

in sect (in′sekt), a small, cold-blooded animal with six legs whose body is divided into three parts.

in tes tine (in tes′tin), a long tube into which food goes from the stomach.

jel ly fish (jel′i fish′), a water animal whose soft body is made of a clear, jellylike material.

joint (joint), the place where two bones are joined together so that they can move.

Ju pi ter (jü′pi tər), 1. the largest planet. 2. the king of the gods in old stories.

large in tes tine (lärj in tes′tin), a tube connected with the small intestine. Food that has not been digested passes out of the body from the large intestine.

lig a ment (lig′ə mənt), a strong band that connects bones or holds parts of the body in place.

liq uid (lik′wid), a material like water; neither a solid nor a gas.

Lit tle Dip per (lit′əl dip′ər), a group of stars in the constellation Ursa Minor.

liv ing (liv′ing), alive now or alive at one time.

lode stone (lōd′stōn′), a kind of rock that attracts iron and steel just as a magnet does.

lungs (lungz), the parts through which air gets into the bodies of many animals.

mag net (mag′nit), a piece of iron, steel, or other material that attracts other pieces of iron or steel.

mag net ic (mag net′ik), attracted by a magnet.

mag net ize (mag′ni tīz), make into a magnet.

mag no li a (mag nō′li ə), a tree with large white, pink, or purplish flowers.

mam mal (mam′əl), a warm-blooded animal that has fur or hair. The mother feeds its young with milk from its own body.

Mars (märz), the planet between the earth and Jupiter.

Mer cu ry (mėr′kū ri), the planet nearest to the sun.

me te or (mē′ti ər), mass of rock or metal that falls through the sky toward the earth. It is often called a shooting star.

me te or ite (mē′ti ər īt), a piece of a meteor that has fallen to the earth.

mi cro scope (mī′krə skōp), an instrument that makes very small things look larger.

molt (mōlt), shed skin or feathers.

moth (môth), an insect that looks much like a butterfly but has a heavier body and feathery feelers.

mus cles (mus′əlz), the parts of the body that are fastened to the bones and make them move.

Nep tune (nep′tūn), the large planet that is next to the farthest from the sun.

nerves (nėrvz), the white threadlike parts of the body that carry messages to and from the brain in all parts of the body.

non-liv ing (non liv′ing), not alive now and never alive.

non-mag net ic (non′mag net′ik), not attracted by a magnet.

O ri on (ō rī′ən), a constellation in the southern sky.

ox y gen (ok′si jən), a gas that makes up part of the air. It cannot be seen or smelled.

pas teur ize (pas′tər īz), heat hot enough and long enough to kill germs.

per spi ra tion (pėr′spi rā′shən), sweat.

plan et (plan′it), one of the big balls that move around the sun. The earth is a planet.

Plu to (plü′tō), the planet farthest from the sun.

Po lar is (pō lãr′is), a name for the North Star, or the Pole Star.

pole (pōl), 1. either end of the earth's axis. 2. one of the two places on a magnet where its force is strongest.

por cu pine (pôr′kū pīn), a mammal whose body is covered with spines or quills.

pore (pōr), a very small opening in the skin through which sweat comes out of the body.

pos ture (pos′chər), a way of holding the body.

pu pil (pū′pəl), the black spot in the center of the eye through which light gets into the eye.

re flect (ri flekt′), throw back.

re pel (ri pel′), push away from itself.

rep tile (rep′til or rep′tīl), a cold-blooded animal whose body is covered with scales. It has lungs for breathing.

re volve (ri volv′), move in a circle.

Ri gel (rī′jəl), a large, bright star in the constellation Orion.

ro tate (rō′tāt), turn around an axis.

salamander (sal′ə man′dər), an amphibian that is shaped like a lizard.

saliva (sə lī′və), the liquid in the mouth that helps dissolve food.

sap (sap), the liquid that travels through a plant and carries dissolved minerals and food.

Saturn (sat′ərn), the large planet that has rings around it.

scales (skālz), the thin, flat pieces of hard material that fit over one another to make the skin of reptiles and most fishes.

scientist (sī′ən tist), a person who spends his life studying science.

season (sē′zən), spring, summer, autumn, or winter.

sea urchin (sē ėr′chin), a small, round sea animal with a spiny shell.

senses (sen′siz), seeing, hearing, smelling, touching, and tasting. Your eyes, ears, nose, etc., give your body the sense of sight, the sense of sound, the sense of smell, etc.

skeleton (skel′i tən), 1. the framework of bones in the body. 2. the hard outside covering of an insect's body.

skull (skul), the rounded covering of bones in the head. It protects the brain.

small intestine (smôl in tes′tin), the part of the intestine connected with the stomach. Most of the food digests there.

solid (sol′id), a material that keeps its shape; neither a liquid nor a gas.

spinal cord (spī′nəl kôrd), a long white cord that runs through the center of the backbone.

spine (spīn), the backbone.

spore (spōr), a tiny part of a plant that grows into a new plant. Some plants have spores instead of seeds.

stage (stāj), one step in the growth of something.

star (stär), a big ball of glowing gases that looks like a bright point in the sky at night.

starfish (stär′fish′), a sea animal with five arms.

stomach (stum′ək), the part of the body where food goes to be mixed and changed so that the body can use it.

structure (struk′chər), the parts of anything and the way they are put together.

symptom (simp′təm), a sign that something is wrong with a person's body and that he is sick.

telescope (tel′i skōp), an instrument that makes things far away look nearer.

thermometer (thər mom′i tər), an instrument that measures how hot something is.

trunk (trungk), the main stem of a tree.

Uranus (ūr′ə nəs), the planet between Saturn and Neptune.

Ursa Major (ėr′sə mā′jər), the Big Bear, a constellation in the northern sky. The Big Dipper is in Ursa Major.

Ursa Minor (ėr′sə mī′nər), the Little Bear, a constellation in the northern sky. The Little Dipper is in Ursa Minor.

vapor (vā′pər), a gas, such as water vapor, made from a liquid or a solid.

Venus (vē′nəs), the brightest planet.

vitamin (vī′tə min), one of the materials in food that the body needs to grow properly and to protect it from certain diseases.

warm-blooded (wôrm′blud′id), having blood whose temperature stays about the same all the time.

windpipe (wind′pīp′), the tube that carries air to and from the lungs.

INDEX

IN THE NEXT FEW PAGES is a list of things that your book tells about. This list is called an *index*. You can use the index to help you find things in your book.

Notice that all the words beginning with *A* come first. All words that begin with *B* come next. Find the words that begin with *S*.

Suppose that you want to find out what kind of animal a cat is. First, look for *cat* in the index. What pages in your book tell about cats? Look at page 12 and find out what it tells you about cats. What does page 20 tell you? Does page 21 tell you what kind of animal a cat is?

Does glass belong to the group of living things or to the group of nonliving things? Find the pages in your book that tell you.

A star after a number (like 29*) means that there is a picture on that page. What page has a picture of a cat? What pages have pictures of frogs?

Accidents, prevention of, 174-179

Air, living things must have, 12, 22, 47-48; how birds get it, 25; how reptiles get it, 28-29; how fish get it, 31; how amphibians get it, 32; how insects get it, 35; takes up space, 48*-49*; what it is made of, 49-50; where found, 50-51; how plants get it, 54*-55*; how body gets it, 80-81; no air on moon, 126

Alnico magnet, 140, 141*

Amphibians, structure of, 31-32*, 34, 71; growth of, 191-194

Animals, 17-18; structure of, 19-20, 71-72*; groups of, 21-37; use air, 52-53; use water, 62-63; skeletons of, 71-72*; growth of, 183-188

Ant, 33, 34*

Apple, flower, 40*

Aquarium, 191

Armadillo, 22*

Arms, 68, 70-71

Aviators, 48

Axis, 97*-98, 104*

Backbone, 70-71*, 72*

Bass, 30*

Bean, 39*, 40, 60-61*, 197*-198*, 199, 200, 208*, 210*-211

Bear, 196

Bee, 33, 189

Betelgeuse, 120*-121*

Bicycle, safety with, 175*, 177*

Big Bear, 116-117*

Big Dipper, finding, 116*-117, 118*, 123*

Bird, 18; structure of, 24-25, 71; growth of, 194-196

Blood, temperature of, 22; carries food, 63, 78-79; carries oxygen, 63; how it gets oxygen, 80-81

Blood vessels, 78-80, 81*

Bluejay, 24, 195
Body, like a machine, 67-69, 157, 160; parts of, 68-85; how uses food, 76-80; how parts work together, 86-88
Bones, what they do, 70-72; how they are held together, 71, 73
Brain, location, 71; what it does, 86-88, 165
Breathing, mammals, 22; birds, 25; reptiles, 28, 35; fish, 31; amphibians, 32, 35; insects, 35; plants, 54-55
Breathing holes, in insects, 35
Bud, 201*
Bumblebee, 34*
Burdock, 203
Butterfly, 8*, 9-10, 12, 35*, 187*-188, 189, 191*

Canada geese, 195*
Canary, 24
Candy, 168
Canis Major, 120*
Canis Minor, 120*
Carbon dioxide, 50; how plants use, 55
Cartilage, 71
Cassiopeia, 118*, 119*
Cat, 12; structure of, 19*, 20, 21
Caterpillar, growth, 184, 185, 186*-189
Cecropia moth, 188*-189*
Celery, 60*
Chicken, structure of, 19*, 20
Chickweed, 203
Chipmunk, 22*
Chrysalis, 186*, 187, 189
Circus parade, 86*-87
Clam, 10, 14, 37
Clothing, 170-171
Coasting, safety in, 178*
Cocoon, 188*, 189
Cold-blooded, meaning of, 28; animals that are, 28, 30-31, 32
Compass, how to make, 150*-152; use of, 152*-154
Cone, pine, 14, 42-43*
Constellations, 115; myths about, 116-120; in northern sky, 116*-119, 118*; in southern sky, 119-121, 120*; why they seem to move, 122*-123
Corn, 197-199, 200, 202, 207*, 208
Cornstalk, 207*
Corn tassel, 41
Crayfish, 10, 36*
Cricket, 33, 34*; growth of, 190*
Crocodiles, 28, 29*

Daddy-longlegs, 35*-36
Daisy, 203
Damsel fly, 34*
Dandelion, 203
Day, what causes day, 93, 98-100; changes in length, 105-106*; temperature change in summer and winter, 107-109
Deserts, 46*, 47, 56
Dew, 58
Digestion, 76-78, 77*
Disease, how to keep from catching, 172-174
Diver, 48, 51*
Dog, 18, 183
Dog Star, 120*
Duck, 15, 195

Ears, 84*, care of, 162-163
Earth, light and heat of, 91-93, 98; size compared with sun, 93; distance from sun, 93; shape, 94-96; how it moves, 96-99, 104-105; poles, 98, 154*; as a clock, 100-103; a planet, 130; as a magnet, 149-150
Earthworm, 37, 51
Elbow, 73-74*
Electric tumblebug, 34*
Evergreen tree, 38*
Exercise, 169
Eyes, 83*-84; testing, 159*; how to take care of, 163*

Feelers, 33*-35
Feet, care of, 171*
Fern, 41*
Fertilizer, 60

Fins, 30

Fire, safety with, 175-176

Fish, how they breathe, 30-31*, 50; structure of, 30*-31, 34, 71; different kinds of, 30*

Flower, opening of magnolia, 12*-13*; what scientist means by, 39-40; bean, 39*; apple tree, 40*; maple, 40*; pussy willow, 40*; walnut, 41*

Fly, disease spread by, 172-173; growth of, 189

Food, for plants, 59-61, 62; for people, 62, 68-69; digestion of, 76-77; carried by blood, 78, 79; kinds of, 166-168; keeping clean, 172*-173

Force, of magnets, 143-144*, 145

Frog, 19, 20*, 21, 32, 51*; growth of, 185, 191-192*, 193*

Frost, 58, 64*

Garden spider, 35*

Gas, what it is, 49

Gasoline, 49

Geese, 195*

Geranium, 17*, 209*, 211

Germs, what they are, 82; protecting body from, 164*-165, 172-174; destroy, 173-174; in milk, 173; in water, 173-174; spreading, 173*-174

Gills, 30-31*, 32, 192

Giraffe, 21*

Glass, 10, 11, 16

Goldenrod, 203

Goldfish, 30-31

Grass, 41

Grasshopper, 10, 33, 35, 47; growth of, 189, 190*

Great Dog, 120*

Gristle, 71

Ground beetle, 34*

Growth, of animals, 184-185; of insects, 186-190; of amphibians, 191-194; of birds, 194-196; of mammals, 196; of plants, 197-212; of trees, 200-201*; of roots, 202-204; of stems, 205-207

Hail, 58

Head, 71

Heart, 72, 78-79*, 81*, 160-161; rate of beat, 159; care of, 161

Horseshoe, 200-201

House centipede, 35*

Insect, 34*, 35*, 187*, 188*, 189*, 190*, 191*; structure of, 33*-36; breathing of, 35; growth of, 186-190

Intestine, small intestine, 77*; large intestine, 77*, 78

Jellyfish, 70*

Joints, use in body, 73-74*

Juices, in body, 62, 77

Jupiter, 130*, 132*

Kitten, 11, 12, 196

Leaves, 39*; how leaves take in air, 54*-55; as food, 167; turn toward light, 211-212*

Legs, 68, 71, 74*

Ligaments, 71, 73

Light, what makes light, 91-92; why sun gives light, 92-93; plants grow toward, 212*

Lion, 183*, 196

Liquid, what it is, 49

Little Bear, 116*-117*

Little Dipper, finding, 116*-117, 118*

Little Dog, 120*

Living things, what they are, 11, 12-14; what they need, 13, 22, 47; two groups of, 17-18; on planets, 133-134; how they grow, 183-214

Lizard, 28

Lodestone, 140*, 152

Long-horn beetle, 34*

Luna moth, 35*

Lungs, of mammals, 22; of birds, 25; of reptiles, 28-29; of amphibians, 32, 192; protection of, 72; of person, 80-81*; care of, 161

Machine, how body is like, 67-69
Magnets, kinds of, 140*; what they will pick up, 141-143; force of, 142-144; poles of, 144-146*, 152; how they act, 147-149; why point north and south, 149-150; magnetic pole, 150, 154*
Magnetic pole, 149-150, 154*
Magnolia, 12*-13*
Mammal, structure of, 21*-23*, 34, 71; growth of, 196
Maple tree, 40*
Marionette, 73*
Mars, 130*, 132, 134*
Meadow mouse, 22*
Mercury, 130*, 131
Meteor, 135*
Meteorite, 135-136*
Mice, 196
Microscope, 7*, 54
Milk, 49; in diet, 166-168; care of, 173
Milkweed, 186
Milky Way, 112*, 121
Moles, 51
Molting, birds, 184; snakes, 184*, 194; caterpillar, 184, 187, 188, 189; grasshopper, 189; cricket, 190; frog, 193
Monarch butterfly, growth of, 186*-187*
Month, 129
Moon, distance from earth, 124; how it gets light, 124-125; surface of, 125*-126; no life on, 126; why moon changes shape, 127*-129*; makes months, 129
Mosquito, 213*
Moss, 42
Moth, 188*-189*, 191*
Mouth, 84-85
Muscles, what they do, 74*, 75*; in stomach, 77; in eye, 83
Mushroom, 42*

Neptune, 130*, 132
Nerves, 86-88
Night, what causes, 93, 98-100; length of, 105-106; what we can see in the sky at night, 112-137
Non-living things, 11, 15-16, 17
North Pole, geographic, 98, 152*-153, 154*; of magnet, 145-146; magnetic, 150, 153-154*
North Star, 118*, 122-123*
Nose, 84

Orion, 119*, 120*, 121*, 122
Oxygen, a gas, 49; used by animals, 52-53; used by people, 52*, 53, 80-81; used by plants, 54-55; carried by blood, 63, 80-81; not on moon, 126

Pasteurize, 173
Perspiration, 82
Petunia, 13, 40
Pine cones, 14, 42, 43*
Planet, 130*, 132*, 134*; what a planet is, 130*-133; description of, 131*-133; no living things on, 133-134
Plantain, 203
Plants, 13, 17-18*; why they are living things, 13-14; structure of, 38*-43*; that have seeds, 39*-41*; that do not have seeds, 41*-42*; that have cones, 42-43*; get and use air, 54*-55*; how plants with seeds grow, 197-199; how plants grow taller, 200*-201*; how roots grow longer, 202-204; how stems get thicker, 205-207; what directions parts of plants grow in, 208-212
Pluto, 130*, 132-133
Pointers, in Big Dipper, 118*
Polaris, 118*, 123*
Poles, of the earth, 98, 153-154*; of magnet, 144*-146*, 147-149, 149-152, 153
Pole Star, 118*
Posture, 161
Pores, 82
Praying mantis, 35*
Procyon, 120*
Proper clothing, 170-171
Puffballs, 41*, 42
Pupil of eyes, 83*
Pussy willow, 40*

Rabbit, 21
Radish, 211
Rain, 47, 58
Rats, 10, 17*, 19, 21, 196
Red fox, 22*
Reptiles, structure of, 26*-29*, 185
Rest, 169*-170
Ribs, 71*-72, 80
Rigel, 120*, 121*
Robin, 24, 194-195
Roots, 39; take in water, 60, 204*; growth, 202-204*, 205, 208*-209, 211, 212; get food, 204, 210

Safety, with roller skates, 175*, 176; with bicycles, 175*, 177*; with knives, scissors, 175; with fire, 175-176, 177; with medicine, 176; while walking on highway, 176; while crossing streets, 176*; at drinking fountain, 177, 180*; on playground, 177-178; while coasting, 178*; with ice skates, 178; while swimming, 178-179
Salamander, 32*
Saliva, 62, 77
Sap, 60
Saturn, 130*, 132*
Scales, on reptiles, 26-29*, 27*, 28*; on fish, 30*-31
Science shelf, 9-11*, 16, 17, 18, 38, 44*-45*
Scientist, how he works, 6, 7*, 10, 17, 19, 102, 121, 133, 134
Seasons, 104*, 105-106
Sea urchin, 36, 37*
Seaweeds, 42
Seeds, plants that have, 13, 39*-41*, 42-43*; need water to grow, 61*; growth of, 197*-199*, 208*-211
Sense, of touch, 83; of sight, 83; of hearing, 84*; of smell, 84; of taste, 84-85
Shadow, 108*-109*
Shoes, 171*
"Shooting stars," 134-135*
Sirius, 120*
Skating, safety in, 176, 178
Skeleton, purpose of, 34, 71*; animals without, 37, 70*; number of bones in human, 70; kinds of bones, 71*, 70-72; animal skeletons, 72*
Skin, care of, 82*, 164*-165; of caterpillar, 184
Skull, 71
Skunk, 22*
Sleep, hours needed, 170
Sleet, 58
Snail, 10, 12, 14, 36*
Snake, 10, 13, 14*, 19, 26*-27*, 28, 184*, 185
Snowman, 15*, 183
Solid, what a solid is, 49
South Pole, of earth, 98; of magnet, 144*-146
Sparrow, 24
Spider, 35*-36
Spinal cord, where it is, 71; made of nerves, 86
Spine, 70
Spores, 41*-42
Squirrel, 20*
Starfish, 37*
Stars, shape and size of, 113; what they are, 113; color of, 114*-115*; seem to move, 122, 123*
Steel, 114*
Stems, 39*; how they get thicker, 205*-207*; direction they grow in, 208*, 209*
Stomach, 63, 77*
Structure, what it means, 19-20; of mammals, 21-23; of birds, 24-25; of reptiles, 26-29; of fish, 30-31*; of amphibians, 32; of insects, 33-36, 34*; of plants, 38-43; of trees, 205*
Sugar beet, 203
Sun, why it gives off light, 92; what it is made of, 92, 93*; size of, 93; telling time by, 100-103; stars are suns, 113; lights moon, 124-125
Sundial, 110*
Sunfish, 30
Sun god, 91

Swallowtail butterfly, 35*
Swimming, safety in, 178-179
Symptom, 159

Tadpole, 185, 191-192*, 193*-194
Teeth, 24, 76*, 196; care of, 161-162*
Telescope, 102, 126, 134*
Temperature, of blood, 22; of body, 158-159
Time, telling time by the sun, 100-103*; what makes a day, 101; what makes a year, 104*-105
Toad, 32*, 185, 193-194*
Trees, kinds of, 40-43; growth of, 200*-201, 205*-207, 206*; roots of, 203, 204*
Trunk, body, 68; tree, 201, 205*, 206*
Turtle, 28*

Uranus, 130*, 132
Ursa Major, 116*, 117*
Ursa Minor, 116*, 117*

Venus, 130*, 131*
Vitamins, 166-167

Warm-blooded, 22-25
Wasp, 34*
Water, living things need, 47; where found, 56-58; how evaporates, 57; how condenses, 57*, 58; how dissolves, 59-60; plants must have, 59*-61; why animals need, 62-63; hole, 62*, 63*; in diet, 167; purity of, 173-174; how plants get, 204
Water hole, 62*, 63*
Water lilies, 54*
Water strider, 34*
Water vapor, 57-58
Weed, 203
Wheat, 41, 203
Windpipe, 80, 81*
Wood, once a living thing, 14
Woodchuck, 22*

Year, number of days, 104; seasons of, 104*, 105; what a year is, 104; daylight in months of, 105-106*

Zebra, 14*

12 13 14 15 16 17 18 19 20 21 22 23 24 25 55 54 53 52 51

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